



Attorney Docket No.: BDR 20.411 (021440-89777)

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Inventor: HARALD HOEPPNER

Confirmation No.: 2134

Serial No.: 09/938,957

Filed: August 24, 2001

Title: METHOD FOR PRODUCING MULTI-LAYER...

Examiner: Alicia Ann Chevalier

Group Art Unit: 1772

April 29, 2005

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**PETITION TO ACCEPT MODEL**

S I R:

Accompanying the Response to the Office Action mailed on October 29, 2004, applicant submits a model of a specimen passport comprising the claimed invention. Therein, the sample includes an identity page for a fictitious "Erika Mustermann." The identity page is disposed as the first sheet inside the cover and extends beyond the fold to include a sectioned page.

Therein, the identity page comprises the claimed inventive structure. Specifically, the identity page comprises paper as a carrier material onto which a plastic coating has been firmly extruded to form a thin-gauged combination of layers. The Examiner is requested to note that this page is almost as thin as the paper pages that follow it and as the inventors point out in the enclosed declaration, the page feels almost like paper to a user. Declaration at Note 11. Laminated

structures have a much thicker structure and feel artificial and obstructive in a security product and are not a thin-gauged structured as presently claimed in Claim 1.

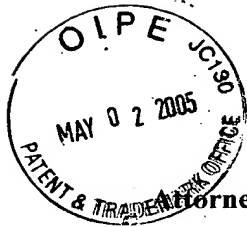
Applicants respectfully request return of the sample to the undersigned Attorney. Any fees associated thereto and any fee associated with this paper may be charged to Deposit Account 50-1290.

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'H. Shakir', is written over a horizontal line.

Hassan A. Shakir  
Reg. No. 53,922  
212.940.6489

CUSTOMER NUMBER 026304  
Docket No.: BDR 20.411 (021440-89777)



Attorney Docket No.: BDR 20.411 (021440-89777)

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Inventor: HARALD HOEPPNER et al.

Confirmation No.: 2134

Serial No.: 09/938,957

Filed: August 24, 2001

Title: METHOD FOR PRODUCING MULTI-LAYER...

Examiner: Alicia Ann Chevalier

Group Art Unit: 1772

April 21, 2005

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**DECLARATION OF MR. DETLEF MÄRTENS AND MICHAEL RADTKE**

S I R:

We, Detlef Märtens and Michael Radtke, Applicants of the referenced application, being able to read, write, and understand the English language, declare as follows:

1. I, Detlef Märtens, am employed as an engineer and product developer for the assignee of the present invention, Bundesdruckerei GmbH ("Bundesdruckerei"). I have a university degree in mechanical engineering and have been employed by Bundesdruckerei since 1986.
2. I, Michael Radtke, am employed as an engineer and product developer for the assignee of the present invention, Bundesdruckerei. I have a university degree in process engineering and processing of synthetic materials and have been employed by Bundesdruckerei since 1997.
3. We understand that this declaration is to be used in support of the patentability of the claims that currently stand rejected in the above referenced U.S. patent application.
4. Bundesdruckerei GmbH has more than 125 years of experience in printing and producing documents that require a high degree of security. Bundesdruckerei was founded by the predecessors to the government of the Federal Republic of Germany as the government

agency responsible for printing the passports, money, treasury notes, banknotes, driving licenses and official personal identity documents for all German citizens and/or residents.

5. Furthermore, Bundesdruckerei has successfully serviced foreign governments by fulfilling their needs for printing banknotes, including among others Israel, Venezuela, and Bolivia, and producing passports and/or personal identification, including among others Romania, Switzerland, and Moldova. Bundesdruckerei has been a contractor to the U.S. Patent & Trademark Office, German Patent & Trademark Office and the European Patent Office. Since 1994, Bundesdruckerei has been a self-funded corporation chartered by the German federal government and since 2000 has been a privately held corporation.
6. We have worked together for several years in a team developing new materials, products and processes for personal documents.
7. At the time the present invention was made, the team was tasked to find a personalizable material, a method of adhering the personalizable material to other materials, and a structure that uses the personalizable material in a security product, such as an identification card, that are made from multiple layers of plastic and have a substrate, i.e. carrier, made from plastic or possibly paper.
8. After studying the known art, goals of the team were set. These goals were that at minimum, it should be easy to use to create the security product, be economical by reducing handling during manufacturing, and be able to be personalized with a laser so that for example the bearer's identity could be added to the security product. These qualities are intended to overcome the significant drawbacks known in the art. We understand that these drawbacks have been described on pages 2 – 4 of the specification as filed with U.S. Patent & Trademark Office.
9. The present invention was the result of that effort and meets the goals that were set forth. We tested numerous known materials and known approaches to produce the desired results. One of the approaches that we tested was the rather well known process of laminating layers on the substrate, i.e. the carrier. We tried numerous approaches of lamination where we altered heat and/or pressure as well as specific changes in compounds. However, while lamination is effective in deterring counterfeiting, it did not meet the high goals we had set forth.
10. The approach we took included the subject of the present invention. This approach was to improve adhesion between the layers being used to produce security documents. More specifically as a goal for security purposes, it was extremely important that the personalizable material be strongly connected to the adjacent layers. Thus, we sought to improve the bond between the layers.
11. We determined through testing and confirmatory trials that extrusion of a plastic coating that was to be used as the personalized layer provided the strongest bond. The bond in fact was stronger and more secure against counterfeiting than connecting the layers by

lamination. To our surprise, we determined that the hardened melt of the extrusion even partly penetrates the carrier material. Advantageously, the plastic material can be extruded onto a paper substrate, i.e. carrier. Since the extruded layer can be very thin, the combination of paper material and extruded layer feels almost like paper to a user. Thus, the resulting composite structure does not break as easily as one just made out of plastic material. This is especially advantageous to keep the fold of passport pages from tearing.

12. It is strength of the bond between the carrier material and the plastic coating that is to be personalized that provides the difference with the known art. This bond can be readily determined by those skilled in the art.
13. Applicants respectfully request passage of the case to allowance.
14. We, individually, declare that all statements made herein are of my own knowledge and are true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. §1001 and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

Detlef Märtens  
Signature

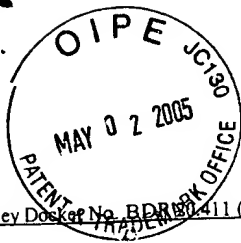
Detlef Märtens  
Printed Name

26.04.2005  
Date

Michael Radtke  
Signature

Michael Radtke  
Printed Name

26.04.2005  
Date



Attorney Docket No. BDR00411 (021440-89777)

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Inventor: Harald HOEPPNER, et al.  
Serial No.: 09/938,957  
Filed: August 24, 2001  
Title: METHOD OF PRODUCING...  
Examiner: Alicia Ann Chevalier  
Art Unit: 1772

**COPY**

October 16, 2003

Director of the U.S. Patent and  
Trademark Office  
P.O. Box 1450  
Alexandria, VA 22313-1450

**INFORMATION DISCLOSURE STATEMENT**

S I R:

In order to comply with discretionary rules 37 CFR §§1.97 and 1.98, attached hereto is a copy of Form PTO-1449 and copies of documents listed thereon. These documents contain information in which the Examiner may consider to be important in deciding whether to issue a patent in the instant application.

As this statement is being filed prior to any action having the effect of closing prosecution in the present application, \$180.00 accompanies this document in accordance with 37CFR §§1.97(c) and 1.17(p).

Also attached is a copy of an International Search Report dated May 5, 2000 from the corresponding International Patent Application. All of the documents listed in Form PTO-1449 appear in the International Search Report.

As one of these documents is written in a language other than English, an English Language abstract is annexed thereto explaining its relevancy in accordance with 37 CFR §1.98(a)(3).

The present Information Disclosure Statement is being submitted in compliance with 37 §CFR 1.56 as an Examiner might consider any cited document important in deciding whether to

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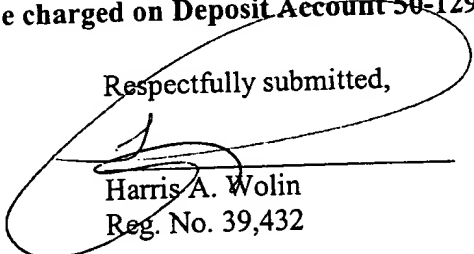
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allow the application to issue as a patent, but the citation of each document is not to be construed as an admission that such document is necessarily relevant or prior art. No representation is intended that the cited documents represent the results of a complete search, and it is anticipated that the Examiner in the normal course of examination, will make an independent search and will determine the best prior art consistent with 37 CFR 1.104 (a), and in the course of such search will review for relevance every document cited on the attached form even if not initialed.

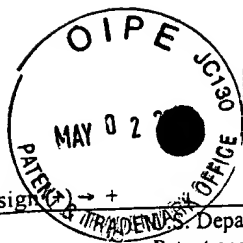
Early and favorable consideration is respectfully solicited.

**Any fee due with this paper may be charged on Deposit Account 50-1290.**

Respectfully submitted,

  
Harris A. Wolin  
Reg. No. 39,432

Customer Number 026304  
(212) 940-8708  
DOCKET NO.: BDR 20.411(021440-89777)



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1449/PTO Patent and Trademark Office

# INFORMATION DISCLOSURE STATEMENT BY APPLICANT

Sheet 1 of 1

Application No. : 09/938,957  
Filing Date : August 24, 2001  
First Named Inventor: H. HOEPPNER  
Group Art Unit : 1772  
Examiner Name : A.A. CHEVALIER  
Attorney Docket No. : BDR 20.411

## U.S. PATENT DOCUMENTS

Examiner Initials	Cite No. <sup>1</sup>	U.S. Patent Document	Kind Code if known <sup>2</sup>	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YYYY	Pages, Columns Lines Where Relevant Passages or Relevant Figures Appear
		5,743,981		LU	04/28/1998	
		4,691,993		PORTER, et al.	09/08/1987	
		5,817,205		KAULE	10/06/1998	
		6,403,169		HARDWICK, et al.	06/11/2002	
		4,507,346		MAURER et al.	03/26/1985	
		5,161,829		DETRICK, et al.	11/10/1992	
		5,407,535		HANSELL	04/18/1995	
		5,213,664		HANSELL	05/25/1993	

## FOREIGN DOCUMENTS

Examiner Initials	Cite No. <sup>1</sup>	Foreign Patent Document Office <sup>3</sup> Number <sup>4</sup> Kind Code <sup>5</sup> (if known)	Country	Name of Patentee or Applicant of Cited Document	Date of Publication of Cited Document MM-DD-YY/Y	Pages, Columns Lines Where Relevant Passages or Relevant Figures Appear
		98/56596	WO	SECURENCY PTY. LTD.	12/17/1998	Corresponds to US Patent No. 6,403,169
		0 628 408	EP	DRAGISA, et al.	12/14/1997	
		0 453 131	EP	JAMES RIVER CORPORATION	10/23/1991	Corresponds to US Patent No. 5,161,829
		0 721 849	EP	NATIONALE BANK VAN BELGIE N.V.	07/17/1996	
		0 858 056	EP	BUNDESDRUCKEREI GMBH	08/12/1998	
		0 428 489	EP	AB TUMBA BRUK	05/22/1991	Corresponds to US Patent Nos. 5,407,535 & 5,213,664

## Other Prior Art-Non Patent Literature Documents

Examiner Initials	Cite No.	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), data, page(s), volume-issue number(s), publisher, country, where published, source.	Applicant check her if English language translation attached
Examiner Signature		Date Considered	

Examiner: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw a line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

<sup>1</sup>Unique citation designation number. <sup>2</sup>See attached Kinds of U.S. Patent Documents. <sup>3</sup>Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). <sup>4</sup>For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. <sup>5</sup>Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.1<sup>6</sup> if possible. <sup>6</sup>Applicant is to place a check mark here if English language Translation is attached.

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Attorney Docket No.: BDR 20.411 (021440-89777)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor : Harald Hoepfner et al.  
Serial No. : 09/938,957  
Filed : August 24, 2001  
Title : Process for the Production of Multi-Layer ...  
Examiner : Alicia Ann Chevalier  
Group Art Unit : 1772  
Confirmation No. : 2134

October 16, 2003

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

RESPONSE TO OFFICE ACTION

Sir:

In response to the Office Action dated July 17, 2003, please amend the subject application as follows:

*Certificate of Mailing for IDS of  
October 16, 2003.*

EL980186093US

Filed by Express Mail  
(Receipt No. EL980186093US)  
on 10-16-2003  
pursuant to 37 C.F.R. 1.10.  
by Thomas Doyle

PATENTS

021440-89771

TO: Assistant Commissioner for Patents

Atty Docket No. BDR 20411

Serial/Patent No. 09/932,957

Date Mailed 10-16-03

Filing date 8-24-2001

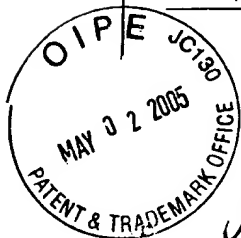
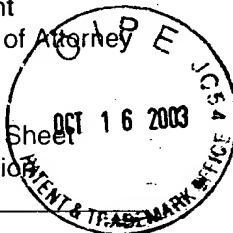
Attorney HANOLIN

Inventor(s): HAROLD HOEPPER ET AL.

Title: Process for the Production of Multi-layer  
EL980186093US

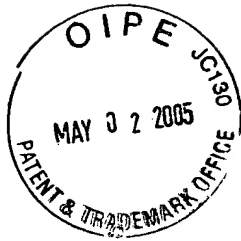
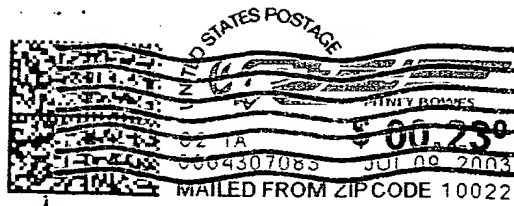
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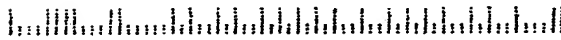
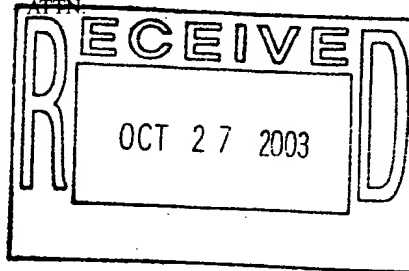


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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 :  
B42D 15/10, B05D 5/12

A1

(11) International Publication Number:

WO 98/56596

(43) International Publication Date: 17 December 1998 (17.12.98)

(21) International Application Number:

PCT/AU98/00438

(22) International Filing Date:

10 June 1998 (10.06.98)

(30) Priority Data:  
PO 7283

11 June 1997 (11.06.97)

AU

(71) Applicant (for all designated States except US): SECURENCY  
PTY. LTD. [AU/AU]; Hume Highway, Craigieburn, VIC  
3064 (AU).

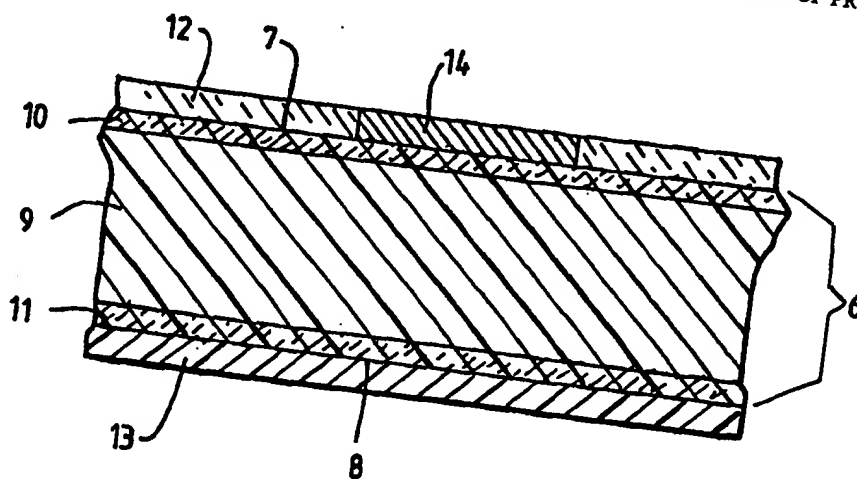
(72) Inventors; and

(75) Inventors/Applicants (for US only): HARDWICK, Bruce,  
Alfred [AU/AU]; 5 Scanlons Road, Wandong, VIC 3758  
(AU). POWER, Gary [GB/GB]; Silloth, Cumbria (GB).(74) Agent: CARTER SMITH & BEADLE; 2 Railway Parade, P.O.  
Box 557, Camberwell, VIC 3124 (AU).(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR,  
BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE,  
GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ,  
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CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.

(54) Title: SECURITY DOCUMENT INCLUDING A MAGNETIC WATERMARK AND METHOD OF PRODUCTION THEREOF



## (57) Abstract

One aspect of the present invention provides a security document (1) comprising: a sheet-like substrate of plastics material (6) having first and second opposing surfaces (7, 8), and a first layer of polymer material (12, 13) coating at least said first opposing surface, wherein said first layer (12, 13) contains magnetic particles for forming a magnetic watermark (14) in a first location on said security document. Another aspect of the present invention provides a method of producing a security document (1), comprising the steps of: (a) forming a sheet-like substrate of plastics material (6) having first and second opposing surfaces (7, 8), (b) coating a first layer of polymer material (12, 13) containing magnetic particles on said first opposing surface, (c) melting at least a portion of said first layer (12) such that the magnetic particles can orient under the influence of a magnetic field, (d) applying said magnetic field so as to form a magnetic watermark (14), and (e) allowing said first layer portion (14) to cool so as to fix the orientation of said magnetic particles.

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**SECURITY DOCUMENT INCLUDING A MAGNETIC WATERMARK  
AND METHOD OF PRODUCTION THEREOF**

The present invention relates to security documents such as banknotes or the like, and is particularly concerned with providing a security document which includes a magnetic device or watermark for verifying the authenticity of the security document. The invention is also concerned with a method of producing such security documents.

A wide variety of security devices or features for security documents, such as banknotes, travellers cheques or the like have been previously proposed. One such security device is a "magnetic watermark" in which a coating of selectively oriented magnetic particles in a binder is applied to a security document. The magnetic watermark is formed by applying a magnetic field to preselected areas of the coating whilst it is in a liquid state, and then causing the coating to solidify.

United States Patent No. 4,186,944 describes one method of applying such a security device to a paper banknote. According to this method, magnetic particles are firstly mixed with the ink which will be used to apply indicia to the surface of the banknote. After mixing, the ink is poured into a cell, then heated, and placed in a magnetic field to orient the magnetic particles in the cell in a particular pattern or design. The banknote is next brought into contact with the cell so that the wet ink is transferred onto one of its surfaces. The transferred ink is absorbed through the surface of the paper and allowed to cool, which causes the orientation of magnetic particles in the transferred ink to be maintained.

A disadvantage of this method is that, in addition to being complex, it requires the magnetic watermark to be coincident with the printed indicia on the

security document, rather than being hidden from visual inspection elsewhere on the document. Moreover, such a method is particularly unsuitable for use in polymer based banknotes, which are formed at least in part from plastics materials, and like security documents. Such documents comprise a flexible film substrate which is coated on one or both sides with an opacifying pigmentary layer. The substrate is then passed through a printing machine to print indicia onto one or both of the opacifying layers. Heating of the ink used to print the relevant indicia on the banknote, so as to allow the orientation of magnetic particles therewithin, could produce a disturbance in the opacifying layer and/or the substrate.

It is therefore desirable to provide a security document and method of producing such security document which allows the convenient application of a magnetic watermark.

It is also desirable to provide a security document and method of producing such security document which enables the orientation of magnetic particles constituting the watermark to be carried out without undue disturbance to the security document itself.

It is further desirable to provide a security document and method of producing such security document which ameliorates or overcomes one or more problems associated with the prior art.

One aspect of the present invention provides a security document comprising:

a sheet-like substrate of plastics material having first and second opposing surfaces, and a first layer of polymer material coating at least said first opposing surface, wherein said first layer contains magnetic particles for forming a magnetic watermark in a first location on said security document.

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PCT/AU98/00438

3

Preferably, the first layer is at least partially transparent.

The first layer may act to protect the security document from wear.

The first layer may include particles acting to improve the adherence of the security document when handled by a user.

- 5            Preferably, the sheet-like substrate comprises a film having first and second opposing sides, at least one of said first or second opposing sides being coated with an opacifying coating.

Moreover, the security document may further comprise indicia formed on or in said opacifying coating.

- 10           In one embodiment of the invention, the security document comprises an opacifying coating applied on at least said first surface.

The security document may also comprise a protective second layer applied on said opacifying coating, which protective second layer may be at least partially transparent.

- 15           The protective second layer may act to protect the security document from wear.

The protective second layer may include particles acting to improve the adherence of the security document when handled by a user.

- 20           Preferably, the sheet-like substrate is a polymeric film having a copolymer outer coating, said copolymer outer coating constituting said first



layer.

The security document may further include verification means at a second location to verify or inspect the magnetic watermark when the security document is folded to superpose the first and second locations or to verify or  
5 inspect a magnetic watermark of another security document.

Another aspect of the present invention provides a method of producing a security document, comprising the steps of:

- (a) forming a sheet-like substrate of plastics material having first and second opposing surfaces,
- 10 (b) coating a first layer of polymer material containing magnetic particles on said first opposing surface,
- (c) melting at least a portion of said first layer such that the magnetic particles can orient under the influence of a magnetic field,
- (d) applying said magnetic field so as to form a magnetic watermark,  
15 and
- (e) allowing said first layer portion to cool so as to fix the orientation of said magnetic particles.

Preferably, the first layer is at least partially transparent.

The first layer may act to protect the security document from wear.

20 The first layer may include particles acting to improve the adherence of the security document when handled by a user.

The sheet-like substrate preferably comprises a film having first and second opposing sides, and the method may further comprise the step of coating at least one of said first or second opposing sides with an opacifying coating

prior to step (c).

The method preferably further comprises the step of forming indicia on at least said first opacifying coating after step (a).

5 The protective layer may be melted in step (d) by the application of induction heating.

Alternatively, the protective layer in step (d) may be melted by subjecting its outer surface to a heated die or roller.

10 The heated die or roller may have a shape similar or corresponding to said magnetic watermark, and the heated die may be borne on the surface of a rotatably driven roller.

A further aspect of the present invention provides a method of producing a security document, comprising the steps of:

- (a) forming a sheet-like substrate of plastics material having first and second opposing surfaces,
- 15 (b) coating a first layer of polymer on said first opposing surface,
- (c) placing magnetic particles in the adhesive of a transfer foil,
- (d) placing the transfer foil on said first layer,
- (e) melting at least a portion of said first layer,
- (f) pressing said transfer foil so that the magnetic particles are
- 20 transferred into said melted first layer portion,
- (g) applying said magnetic field so as to orient said magnetic particles and thereby form a magnetic watermark, and
- (h) allowing said first layer portion to cool so as to fix the orientation of said magnetic particles.

Preferably, the first layer is at least partially transparent.

The first layer may act to protect the security document from wear.

The first layer may include particles acting to improve the adherence of the security document when handled by a user.

- 5       The sheet-like substrate may comprise a film having first and second opposing sides, said method further comprising the step of coating at least one of said first or second opposing sides with an opacifying coating prior to step (b).

- 10       The method may further comprise the step of forming indicia on at least said first opacifying coating after step (a).

Yet another aspect of the present invention provides a method of producing a security document, comprising the steps of:

- (a) forming a sheet-like substrate of plastics material having first and second opposing outer layers containing magnetic particles,
- 15       (b) melting at least a portion of one of said outer layers such that the magnetic particles can orient under the influence of a magnetic field,
- (c) applying said magnetic field so as to form a magnetic watermark,
- (d) allowing said outer layer portion to cool so as to fix the orientation of said magnetic particles, and
- 20       (e) coating a protective layer of polymer material on said outer layer.

The protective layer may be at least partially transparent.

The protective layer may act to protect the security document from wear.

The protective layer may include particles acting to improve the adherence of the security document when handled by a user.

The method may further comprise the step of coating an opacifying layer on said first and second outer layers after step (d).

5       The method may also comprise the step of forming indicia on said opacifying layer.

The protective layer may be melted in step (d) by the application of induction heating.

10       Alternatively, the protective layer in step (d) may be melted by subjecting its outer surface to a heated die or roller.

The heated die or roller may have a shape similar or corresponding to said magnetic watermark.

The heated die may be borne on the surface of a rotatably driven roller.

15       A still further aspect of the present invention provides a method of producing a security document, comprising the steps of:

- (a) forming a sheet-like substrate of plastics material having first and second opposing outer layers containing magnetic particles,
- (b) coating an opacifying layer on said first and second outer layers whilst leaving an un-opacified window area in said opacifying layer,
- 20       (c) melting at least a portion of one of said outer layers within said window area such that the magnetic particles can orient under the influence of a magnetic field,
- (d) applying said magnetic field so as to form a magnetic watermark,

and

(e) allowing said outer layer portion to cool so as to fix the orientation of said magnetic particles.

The protective layer may be at least partially transparent.

5

The protective layer may act to protect the security document from wear.

The protective layer may include particles acting to improve the adherence of the security document when handled by a user.

The method may further comprise the step of coating an opacifying layer on said first and second outer layers after step (d).

10

The method may also comprise the step of forming indicia on said opacifying layer.

The protective layer may be melted in step (d) by the application of induction heating.

15 Alternatively, the protective layer step (d) may be melted by subjecting its outer surface to a heated die or roller.

The heated die or roller may have a shape similar or corresponding to said magnetic watermark.

The heated die may be borne on the surface of a rotatably driven roller.

20 In order that the present invention may be more readily understood, various embodiments thereof will now be described, by way of example only,

with reference to the accompanying drawings, in which:

Figure 1 is a plan view of a banknote in accordance with one embodiment of the present invention;

5      Figure 2 is a cross-sectional view of a portion of a first embodiment of the banknote of Figure 1;

Figure 3 is a cross-sectional view of a second embodiment of the banknote of Figure 1 in which a biaxially oriented polymeric film is used in the banknote;

10      Figure 4 is a diagrammatic representation of a first portion of a process and apparatus suitable for the production of the banknote of Figure 1;

Figure 5 is a diagrammatic representation of a first embodiment of a second portion of a process and apparatus suitable for the production of the banknote of Figure 1; and

15      Figure 6 is a diagrammatic representation of a second embodiment of the second portion of a process and apparatus suitable for the production of the banknote as shown in Figure 5.

Referring now to Figures 1 and 2, there is generally shown a banknote 1 having substantially parallel sides 2 and 3 and substantially parallel ends 4 and 5 and comprising a flexible, sheet-like substrate of plastics material 6 having first and second opposing surfaces 7 and 8. Various indicia may be formed on at least one of the first and second opposing surfaces 7 and 8, such as drawings, writing, and other designs well known to all users of banknotes.

20

5 The substrate 6 is preferably a composite made up of at least one bi-axially oriented polymeric film 9 which is coated on both sides with an opacifying pigmentary coating 10 and 11 comprising a major proportion of pigment in a minor proportion of a cross-linked polymeric binder. A transparent protective coating 12 and 13 is applied to preferably both sides of the substrate 6 in order to protect the banknote 1 from wear. Preferably the transparent protective layer includes silica or like particles so as to improve the adherence of the banknote 1 when it is being handled by a user.

10 At least a portion of the transparent protective layer 12 and/or 13 contains magnetic particles, that is, particles which are able to have a permanent or semi-permanent magnetic polarity and which adopt a specific magnetic orientation in the presence of a magnetic field. A magnetic watermark, such as that referenced 14 in Figure 1, may be formed in one or more of the protective layers 12 and 13 by melting at least the outer layers of the protective layer and  
15 applying a magnetic field such that the magnetic particles in the melted portion of the layer can adopt a specific magnetic orientation, and then allowing the melted portion of the protected layer to cool so that this magnetic orientation becomes semi-permanent or permanent. In this way, a magnetic watermark may be formed at any location on either or both of the outer protective layers  
20 12 and 13 of the banknote 1 without disturbing the underlying substrate or various indicia printed thereupon. In addition, the location, form and application of the magnetic watermark need have no relation to the printed indicia formed on the substrate 6 nor on the method of fabrication of the substrate 6.

25 The magnetic watermark 14 may be viewed by commercially available devices for detecting and visualising magnetic fields. However, in the embodiment of the invention shown in Figure 1, the banknote 1 comprises verification means 15 at one location to verify or inspect the magnetic

watermark 14 at another location when the banknote 1 is folded to superpose these two locations. Accordingly, when the banknote 1 is folded upon itself generally about a line 16 extending transversely across the note as shown in Figure 1, the verifying means 15 maybe used to inspect the magnetic watermark

5 14. The verifying means 15 maybe constituted by a transparent sealed device which contains metallic or like particles whose orientation changes in the presence of a localised magnetic field, which orientation maybe visually detected by a user. Alternatively, the verification means 15 may comprise a transparent sealed device which contains material whose optical properties, such

10 as colour, change in the presence of a localised magnetic field such that a reproduction of the watermark 14 is formed by the verification means 15 when the magnetic watermark 14 and the verification means 15 are superposed.

In another embodiment of the invention the magnetic particles are included in a copolymer outer coating 9(b), 9(c) of Figure 3 of the biaxially

15 oriented polymeric film, and the magnetic watermark created by melting a portion of the copolymer coating whilst applying a magnetic field and thence allowing the coating to cool whilst still under the influence of the field. The magnetic watermark may be created prior to opacification of the film, or alternatively, after opacification by creating the magnetic watermark in the un-

20 opacified window area of the design.

Of course, the verification means 15 maybe used to verify or inspect a magnetic watermark of another security document in the manner described above.

Referring now to Figure 4, the production of banknotes, such as the

25 banknote described above, as a continuous strip or web is shown diagrammatically. The layer or layers of transparent polymer film 9 consist basically of a laminate of three 24 microns sheets 20, 21 and 22 of polymeric



film on each side of which a thin coating of heat activated polymer has been deposited. The three sheets are led together through a pair of heated rollers 23 so as to form them into an intimately bonded laminate 24. This laminate is led through a double set of printing rollers 25 which apply a uniform coating of printing ink onto both surfaces of the laminate 24 to form a substrate 26, which is led through a drying oven 27 within which the coating is dried and cured.

Preferably, prior to the coating step, the laminate 24 is subjected to a known surface treatment to improve the adhesion of the printing ink thereto. A suitable treatment may be the use of corona discharge, this being illustrated diagrammatically at 28 in Figure 3. The treated laminate is coated with a pigmented coating comprising a pigment such as titanium dioxide dispersed within a binder or carrier of heat activated crosslinkable polymeric material. In the coating of the substrate at the rollers 25, a transparent window may be left at intervals corresponding to the location on each banknote where the verification means 15 will be formed.

Finally, the printed laminate 26 is subjected to a further coating step whereby a thin coating of protective and transparent polymeric material is applied to both surfaces of the banknote, this coating serving the combined purpose of providing a soil and solvent resistant outer skin and of providing a binder in which the magnetic particles for forming the magnetic watermark 14 maybe held. In Figure 3, this thin protective coating is shown as being applied by the pair of rollers 29.

In one embodiment of the invention, magnetic particles are firstly mixed with the transparent polymeric material prior to it being coated onto the outer surfaces of the substrate 26 so that this coating step also acts to apply the magnetic particles to one or more of the surfaces of the substrate 26.

Figure 5 shows one way in which the magnetic watermark may be applied to banknotes produced by the above described process. This figure shows the substrate 30 at the stage at which it has passed through the rollers 29. In this embodiment, the coated substrate 30 is fed between a pair of rollers 40 and 41. The upper roller 40 bears on its outer surface one or more dies 42. Each die has on its outer face a design or other indicia corresponding to the shape of the magnetic watermark to be formed in the transparent protective layer 12 of the coated substrate 30. In other embodiments, similar means may be used to form a magnetic watermark in the protective layer 13 of the substrate 30. Either the entire upper roller 40 or the dies 42 are heated so that when they rotate and come into contact with the banknote 30 as it passes between the two rollers 40 and 41, that portion of the transparent protective layer 12 coming into contact with the heated die is caused to melt.

In addition, magnetic field generating means 50 are provided for generating a magnetic field in the vicinity of the melted portions of the protective layer 12, 13. When the magnetic field generated by generating means 50 is applied, the magnetic particles in the melted portions of the protective layer 12 are caused to orient along the field lines of that magnetic field.

Subsequently, the upper roller 40 is rotated such that the die 42 is removed from contact with the coated substrate 30 and therefore ceases to heat the protective layer 12. The banknote 30 is then cooled whilst the magnetic field generated by means 50 is maintained so as to allow those melted portions of the protected layer 12 to return to a non-viscous state and thus fix the orientation of the magnetic particles. A magnetic watermark is thus created in which the magnetic particles in those portions of the protective layer 12 underlying the raised surfaces of the die 42 all have a uniform magnetic orientation.

Whilst Figure 5 shows one manner in which the magnetic watermark may be applied to the banknote 30, it is to be appreciated that several variations or modifications of this described process may be used. For example, whilst the above described process heats and subsequently melts the upper portions of the transparent protective layer 12 by pressing a heated die into contact with the protective layer 12 induction heating may also be used so that direct contact with the protective layer 12 need not occur. In such an arrangement the die 42 may form part of an electromagnetic flux path which causes the outer layers of the protective coating 12 to melt without direct contact of a heated member.

In addition, whilst the magnetic watermark may be in the form of a visually recognisable design, it may also be in the form of a bar code or other machine readable form. In such cases verification means 15 may not be required to verify or inspect the magnetic watermark.

Figure 6 shown an alternative method of applying the magnetic watermark to the banknote or other security document the subject of the present invention. According to this method, the substrate 26 is firstly produced in accordance with the method described in respect of Figure 4, that is by the production of a substrate which is subsequently coated with a transparent protective coating 12 with the exception that magnetic particles are not firstly mixed with the material which forms the protective coating 12. Such a coated substrate which contains at this stage no magnetic particles in its transparent protective coating is represented in Figure 5 by the reference 60.

In addition to the previously described pair of rollers 40 and 41, the heated die 42 and the means 50 for generating a magnetic field, there is also provided a transfer foil 61 which is fed between the pair of rollers 40 and 41 together with, and at the same speed as, the substrate 60. The transfer foil 61 has an adhesive on one of its faces. Magnetic particles are born in the adhesive

of the transfer foil 61. As the heated dies 42 rotate, they press the transfer foil firmly against the banknote 60 which causes both the adhesive on the transfer foil and the upper portions of the protective layer to melt. As described above, a magnetic field is applied by the magnetic field generating means 50 so that those portions of the protective layer which have been melted by the die 42, and into which have been transferred magnetic particles, form a magnetic watermark. The heated die is subsequently rotated out of contact with the transfer foil and the protective layer 12, 13 is left to cool in the presence of the applied magnetic field so that the orientation of the magnetic particles forming the magnetic watermark is fixed.

Various modifications of this process maybe implemented. For example, the above described process may be carried out in two steps, the first of which acts to transfer the magnetic particles into the protective layer whilst the second of which is carried out in the applied magnetic field so as to form the magnetic watermark. In such a case, a heated member, such as a roller, may be used to melt the adhesive on the transfer foil and the outer portions of the protective layer of the coated substrate so as to transfer the magnetic particles born in the adhesive into the protective layer of the banknote. A second head or die may then be used to apply the magnetic watermark in the manner described above.

In addition, the first roller could operate in a magnetic field so that the magnetic particles are transferred into the transparent protective layer with a pre-defined magnetic orientation. In a subsequent operation, a second head or die could be used to melt portions of the transparent protective layer in contact with the die and in the presence of the second magnetic field so as to apply a second magnetic orientation to the magnetic particles in those portions of the transparent protective layer melted in the second operation.

It will be appreciated that various embodiments and alterations may be

made to the embodiment of the present invention described above without departing from the spirit or scope of the present invention.

Claims

1. A security document comprising :  
a sheet-like substrate of plastics material having first and second opposing surfaces, and a first layer of polymer material coating at least said first opposing  
5 surface, wherein said first layer contains magnetic particles for forming a magnetic watermark in a first location on said security document.
2. A security document according to claim 1, wherein said first layer is at least partially transparent.
3. A security document according to either one of claims 1 or 2, wherein  
10 said first layer acts to protect the security document from wear.
4. A security document according to claim 3, wherein said first layer includes particles acting to improve the adherence of the security document when handled by a user.
5. A security document according to any one of claims 1 to 4, wherein said  
15 sheet-like substrate comprises a film having first and second opposing sides, at least one of said first or second opposing sides being coated with an opacifying coating.
6. A security document according to claim 5, and further comprising indicia formed on or in said opacifying coating.
- 20 7. A security document according to claim 1, and further comprising an opacifying coating applied on at least said first surface.

8. A security document according to claim 7, and further comprising a protective second layer applied on said opacifying coating.
9. A security document according to claim 8, wherein said protective second layer is at least partially transparent.
- 5 10. A security document according to either of claims 8 or 9, wherein said protective second layer acts to protect the security document from wear.
11. A security document according to claim 10, wherein said protective second layer includes particles acting to improve the adherence of the security document when handled by a user.
- 10 12. A security document according to claim 1 or any one of claims 7 to 11, wherein said sheet-like substrate is a polymeric film having a copolymer outer coating, said copolymer outer coating constituting said first layer.
13. A security document according to any one of claims 1 to 12, and further including verification means at a second location to verify or inspect the
- 15 magnetic watermark when the security document is folded to superpose the first and second locations or to verify or inspect a magnetic watermark of another security document.
14. A method of producing a security document, comprising the steps of :
- (a) forming a sheet-like substrate of plastics material having first and
- 20 second opposing surfaces,
- (b) coating a first layer of polymer material containing magnetic particles on said first opposing surface,
- (c) melting at least a portion of said first layer such that the magnetic particles can orient under the influence of a magnetic field,

(d) applying said magnetic field so as to form a magnetic watermark,  
and

(e) allowing said first layer portion to cool so as to fix the orientation  
of said magnetic particles.

5 15. A method of producing a security document according to claim 14,  
wherein the first layer is at least partially transparent.

16. A method of producing a security document according either of claims  
14 or 15, wherein said first layer acts to protect the security document from  
wear.

10 17. A method of producing a security document according to claim 16,  
wherein said first layer includes particles acting to improve the adherence of the  
security document when handled by a user.

15 18. A method of producing a security document according to any one of  
claims 14 to 17, wherein said sheet-like substrate comprises a film having first  
and second opposing sides, said method further comprising the step of coating  
at least one of said first or second opposing sides with an opacifying coating  
prior to step (c).

19. A method of producing a security document according to claim 18, and  
further comprising the step of forming indicia on at least said first opacifying  
20 coating after step (a).

20. A method of producing a security document according to any one of  
claims 14 to 19, wherein the protective layer is melted in step (d) by the  
application of induction heating.



21. A method of producing a security document according to any one of claims 14 to 19, wherein the protective layer in step (d) is melted by subjecting its outer surface to a heated die or roller.
22. A method of producing a security document according to claim 21,  
5 wherein the heated die or roller has a shape similar or corresponding to said magnetic watermark.
23. A method of producing a security document according to either of claims 21 or 22, wherein the heated die is borne on the surface of a rotatably driven roller.
- 10 24. A method of producing a security document, comprising the steps of :  
(a) forming a sheet-like substrate of plastics material having first and second opposing surfaces,  
(b) coating a first layer of polymer on said first opposing surface,  
(c) placing magnetic particles in the adhesive of a transfer foil,  
15 (d) placing the transfer foil on said first layer,  
(e) melting at least a portion of said first layer,  
(f) pressing said transfer foil so that the magnetic particles are transferred into said melted first layer portion,  
(g) applying said magnetic field so as to orient said magnetic particles  
20 and thereby form a magnetic watermark, and  
(h) allowing said first layer portion to cool so as to fix the orientation of said magnetic particles.
25. A method of producing a security document according to claim 24, wherein the first layer is at least partially transparent.
- 25 26. A method of producing a security document according to either of claims

24 or 25, wherein said first layer acts to protect the security document from wear.

27. A method of producing a security document according to claim 26, wherein said first layer includes particles acting to improve the adherence of the security document when handled by a user.

28. A method of producing a security document according to any one of claims 24 to 27, wherein said sheet-like substrate comprises a film having first and second opposing sides, said method further comprising the step of coating at least one of said first or second opposing sides with an opacifying coating prior to step (c).

29. A method of producing a security document according to claim 28, and further comprising the step of forming indicia on at least said first opacifying coating after step (a).

30. A method of producing a security document, comprising the steps of :

15 (a) forming a sheet-like substrate of plastics material having first and second opposing outer layers containing magnetic particles,

(b) melting at least a portion of one of said outer layers such that the magnetic particles can orient under the influence of a magnetic field,

(c) applying said magnetic field so as to form a magnetic watermark,

20 and

(d) allowing said outer layer portion to cool so as to fix the orientation of said magnetic particles, and

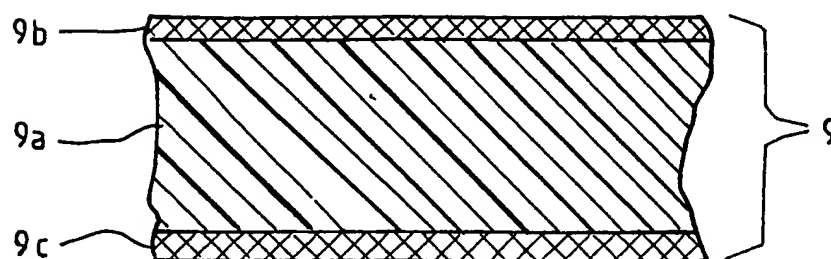
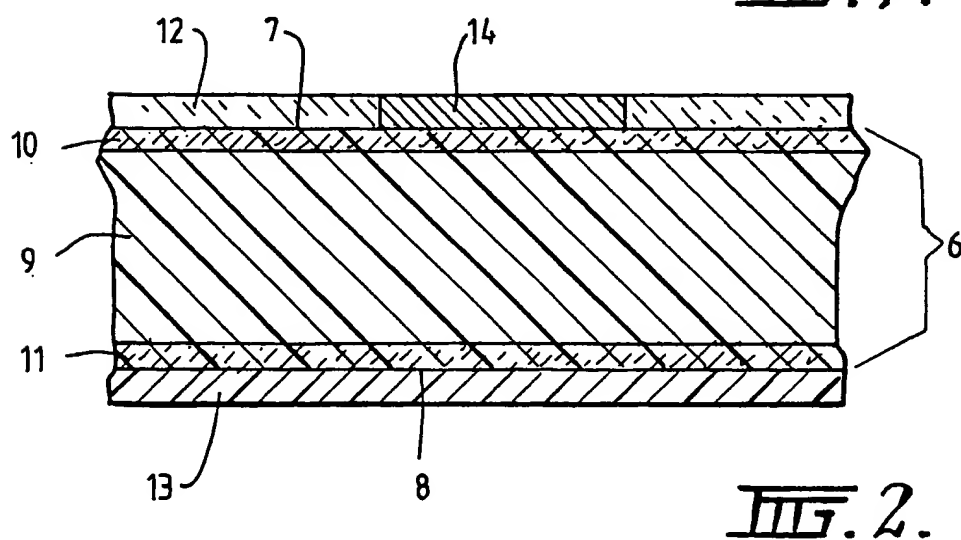
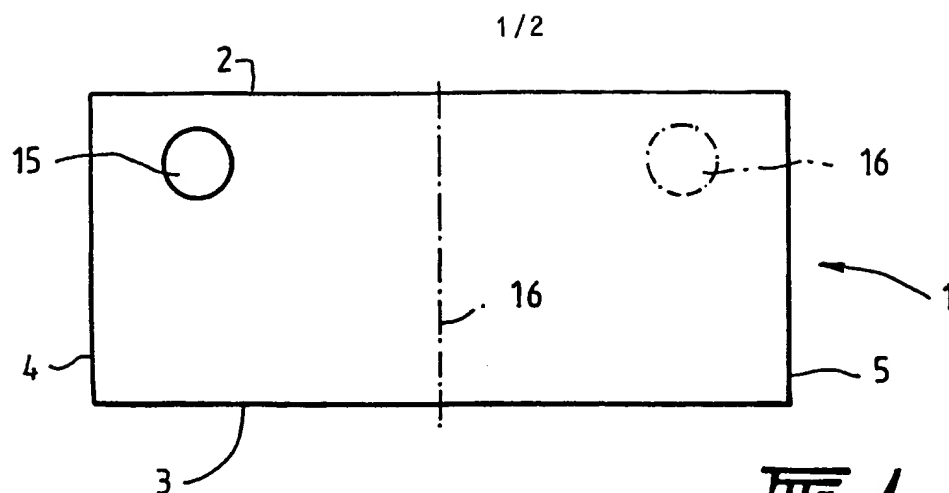
(e) coating a protective layer of polymer material on said outer layer.

31. A method of producing a security document according to claim 30, wherein the protective layer is at least partially transparent.

32. A method of producing a security document according to either of claims 30 or 31, wherein said protective layer acts to protect the security document from wear.
33. A method of producing a security document according to claim 32,  
5 wherein said protective layer includes particles acting to improve the adherence of the security document when handled by a user.
34. A method of producing a security document according to any one of claims 30 to 33, and further comprising the step of coating an opacifying layer on said first and second outer layers after step (d).
- 10 35. A method of producing a security document according to claim 34, and further comprising the step of forming indicia on said opacifying layer.
36. A method of producing a security document according to any one of claims 30 to 35, wherein the protective layer is melted in step (d) by the application of induction heating.
- 15 37. A method of producing a security document according to any one of claims 30 to 35, wherein the protective layer in step (d) is melted by subjecting its outer surface to a heated die or roller.
38. A method of producing a security document according to claim 37,  
wherein the heated die or roller has a shape similar or corresponding to said  
20 magnetic watermark.
39. A method of producing a security document according to either of claims 37 or 38, wherein the heated die is borne on the surface of a rotatably driven roller.

40. A method of producing a security document, comprising the steps of :
- (a) forming a sheet-like substrate of plastics material having first and second opposing outer layers containing magnetic particles,
  - (b) coating an opacifying layer on said first and second outer layers
  - 5 whilst leaving an un-opacified window area in said opacifying layer,
  - (c) melting at least a portion of one of said outer layers within said window area such that the magnetic particles can orient under the influence of a magnetic field,
  - (d) applying said magnetic field so as to form a magnetic watermark,
  - 10 and
  - (e) allowing said outer layer portion to cool so as to fix the orientation of said magnetic particles.
41. A method of producing a security document according to claim 40, wherein the protective layer is at least partially transparent.
- 15 42. A method of producing a security document according to either of claims 40 or 41, wherein said protective layer acts to protect the security document from wear.
43. A method of producing a security document according to claim 42, wherein said protective layer includes particles acting to improve the adherence
- 20 of the security document when handled by a user.
44. A method of producing a security document according to any one of claims 40 to 43, and further comprising the step of coating an opacifying layer on said first and second outer layers after step (d).
45. A method of producing a security document according to claim 44, and
- 25 further comprising the step of forming indicia on said opacifying layer.

46. A method of producing a security document according to any one of claims 40 to 45, wherein the protective layer is melted in step (d) by the application of induction heating.
47. A method of producing a security document according to any one of  
5 claims 40 to 45, wherein the protective layer in step (d) is melted by subjecting its outer surface to a heated die or roller.
48. A method of producing a security document according to claim 47, wherein the heated die or roller has a shape similar or corresponding to said magnetic watermark.
- 10 49. A method of producing a security document according to either of claims 47 or 48, wherein the heated die is borne on the surface of a rotatably driven roller.
50. A security document substantially as hereinbefore described with reference to the accompanying drawings.
- 15 51. A method of producing a security document substantially as hereinbefore described with reference to the accompanying drawings.



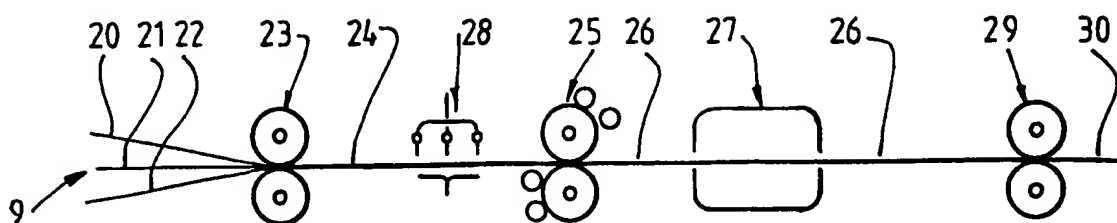


FIG. 4.

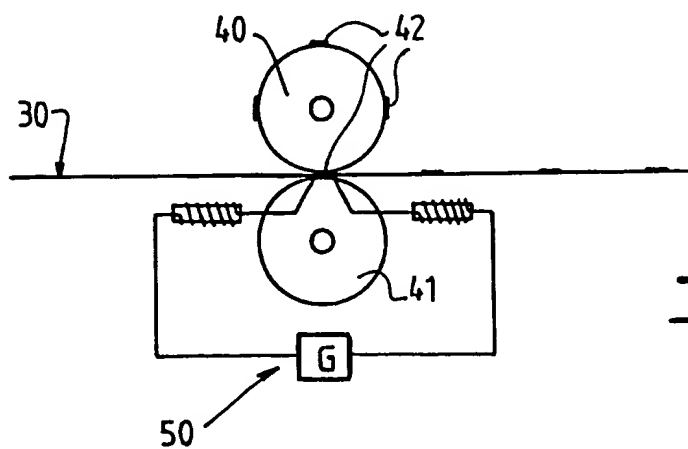


FIG. 5.

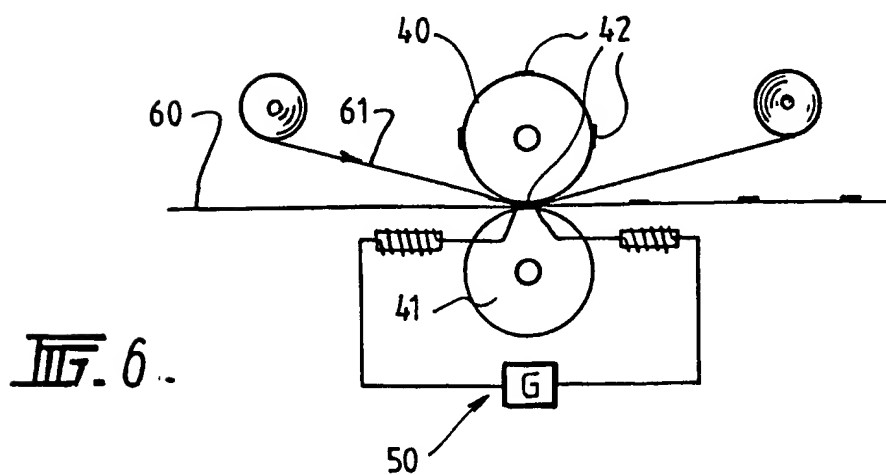


FIG. 6.

# INTERNATIONAL SEARCH REPORT

International Application No.  
PCT/AU 98/00438

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
Int Cl <sup>6</sup> : B42D 15/10; B05D 5/12		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols) IPC B42D 15/10; B44F 1/12; B41M 3/14; B05D 5/12		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU: IPC: as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DERWENT : (MAGNET: OR WATERMARK#) AND (SECURIT: OR BILL# OR NOTE# OR BANKNOTE# OR CHEQUE# OR CHECK) JAPIO : as per DERWENT		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3878367 A (FAYLING et al) 15 April 1975 abstract, column 2 line 61-column 3 line 60	1-51
X	US 4743490 A (FAYLING) 10 May 1988 whole document	1-51
Y	GB 2176746 A (PILOT MAN-NEN-HITSU KABUSHIKI KAISHA) 7 January 1987 whole document	1-51
Y	US 4186944 A (PEARCE) 5 February 1980 column 1 line 13-39, column 2 line 54-column 3 line 18	1-51
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 26 June 1998		Date of mailing of the international search report 10 JUL 1998
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (02) 6285 3929		Authorized officer  SOOSA GNANASINGHAM Telephone No.: (02) 6283 2172



# INTERNATIONAL SEARCH REPORT

international Application No.

PCT/AU 98/00438

C (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4180207 A (LEE) 25 December 1979	
A	US 5383687 A (SUESS et al) 24 January 1995	

### Information on patent family members

**PCT/AU 98/00438**

Patent Document Cited in Search Report				Patent Family Member			
US	3878367	CA	1031858	DE	2421469	FR	2228265
		GB	1466329	IT	1011317	JP	50015511
US	4743490	NONE					
GB	2176746	AU	58054/86	CA	1252207	DE	3617788
		FR	2582833	JP	61273786	SE	8602435
US	4186944	DE	2516832	GB	1510105	JP	50143607
		US	3998160	US	4186944		
US	4180207	DE	2754908	GB	1562248	JP	53092199
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D-81633 München (DE)**(54) **Security paper with color mark.**

(57) A security paper is provided for incorporation in a security document, or other document having intrinsic value. The security paper includes a resinous substrate sheet (14) on which indicia (18) are printed. Paper sheets (12,16) are laminated on either side of the resinous substrate sheet using a suitable adhesive (28,30). In the laminated security paper, the indicia printed on the substrate sheet are undetectable when viewed in reflected light, but become apparent when viewed transmitted light within the visible spectrum. The security paper may be incorporated in a security document in which a set of indicia (20,22) printed on at least one of the outer faces of the paper sheets, such that the indicia on the substrate and the indicia on the document form a total image when viewed in transmitted light. A method for manufacturing the security paper is also provided.

**EP 0 628 408 A1**

The present invention relates generally to security papers and, more particularly, to a laminated security paper for use in making banknotes, passports, stock certificates, checks and the like.

A great number of printed documents require highly reliable means of ensuring their authenticity due to some intrinsic value associated with them. These documents range from banknotes to property titles, and include such things as negotiable instruments, stock certificates, checks, and passports. To be truly of value to the user or holder of the document, the means employed to indicate authenticity must be readily and easily detectible. Moreover, to serve the more general purpose of allowing the public at large to rely on the authenticity of the documents, these means should be permanent, durable, and difficult to replicate. This latter quality is particularly important to preclude, or at least to dissuade, attempts at counterfeiting the documents in order to ensure a maximum degree of confidence in the original document. In the case of banknotes, passports, checks, and other intrinsically valuable documents, confidence in the authenticity of the document is especially important, as any member of the public might become a holder or user of the document at any time. Thus, creators of such intrinsically valuable documents are most often concerned with providing a means by which the public may verify the authenticity of the documents because, ultimately, it is the unsuspecting public who is most at risk of being duped by counterfeits.

Historically, attempts at guaranteeing the authenticity of intrinsically valuable documents have concentrated on two aspects of the documents: (1) the paper employed as the basis for the document, typically referred to in the art as "security paper," and (2) some security feature either incorporated in the paper or added during the transformation of the paper into the final document. Due to their important role in providing lasting documents and a dependable basis for public confidence in the authenticity of such documents, both the security paper and the security feature must respond to numerous, stringent criteria relating to their design and utility. Criteria for security papers include both physical and optical requirements. The requirements of security features relate not only to their physical properties, but also to the relative difficulty of their replication and to their reliability in guaranteeing the authenticity of the final document.

The physical requirements imposed on security papers, particularly papers used in the manufacture of banknotes, are generally much more strict than for other types of paper. One such requirement is the "basis weight" or the "grammage" of the paper, usually expressed in grams per square meter, or pounds per ream. For most security papers, the basis weight must fall within a fairly narrow range so as to lend sufficient body, or feel, to the document to satisfy the expectations of holders, while allowing the document to be easily folded and unfolded. Closely related to the basis weight is the "caliper," or thickness of the paper, expressed in fractions of a millimeter or inch. It is important that the caliper of the security papers used in any particular application function well with machines, such as automatic teller machines and high speed sorters, which will inevitably handle the final documents.

Strength and durability are crucial properties of security papers because they give the final document its ability to withstand the use, and abuse, likely during its service life. The tensile strength, expressed in units of force per unit width, represents the greatest longitudinal stress a piece of paper can bear without tearing apart. Other strength parameters include wet tensile strength, breaking strength, tearing strength, and folding endurance. Because banknotes are inevitably folded and unfolded many times during their circulation life, high strength and great folding endurance are required of the papers from which they are made. Banknote paper is typically designed to allow some 5,000 to 8,000 folds during its expected circulation life. It should be noted that ratings of security papers based upon the number of folds the papers can endure without tearing may vary widely depending upon the test procedures employed. Moreover, while permitting a considerable number of folds, modern banknote paper must retain some degree of rigidity, or resistance to bending, sometimes referred to as "crispness," to pass successfully through automatic teller machines and high speed sorters.

Other important physical properties of security papers include porosity, printability, and dimensional stability. Because porosity is related to the soilability of a paper, that is, the tendency to absorb or retain impurities, a relatively low porosity is generally desirable for security papers, to increase the likelihood that the document will maintain a clean appearance throughout its useful life. At the same time, security papers require good printability characteristics to ensure accurate and precise impression in the printing processes employed in the manufacture of the final document, as well as proper penetration and adhesion of inks used in the document production. Printing processes used to make certain intrinsically valuable documents may place extreme demands on the paper. Intaglio, or gravure printing, for example, often used in printing banknotes and other documents, involves tremendous pressures between the printing plates and the paper. The paper selected must withstand these processes without loss of physical integrity. Finally, the paper's dimensional stability is important, both during the manufacturing processes and during the service life of the final document. In particular, the paper should not swell or contract excessively due to changes in humidity

that typically occur during the manufacturing process and during ordinary use.

Security papers typically exhibit certain optical properties that affect their usefulness and acceptability to the public. The most important of these properties are the surface characteristics of the paper, and the paper's opacity. Surface characteristics include color, brightness, gloss, finish and smoothness. These parameters are usually specified by the designer of the final document based upon the aesthetics desired in the document; and various processes, such as coating and calendering, may be used to obtain the desired appearance and feel. The opacity of the paper refers to the relative inability of light to pass through the paper. Opacity is generally represented in terms of the percentage of the light incident on one side of the paper that is not transmitted through the paper to an observer on the other side, but is reflected or absorbed by the paper. High opacity, that is, in excess of about 75%, is generally desirable for security papers. However, variations in opacity may actually serve as security features in the final document, as in the case of watermarks, wherein the image or mark, visible in transmitted light, is formed by causing the paper to take on different levels of opacity in such a way as to define a recognizable mark.

The selection and specification of the security feature to be incorporated into an intrinsically valuable document is often intimately related to the specification of the security paper in connection with which it is to be used. There are several reasons for this. First, the security feature is often a quality of the paper itself, such as a watermark or a particular paper composition. Even where the feature may be said to constitute an element separate from the paper, such features are often imbedded in the paper during the papermaking process. This is true for a great number of security features, including so called security threads, chemical additives, colored confetti, and thin tapes containing microtext or other indicia. In addition, even surface-applied security features must be compatible with the underlying paper to provide the desired adhesion and durability characteristics to the resulting document. Such surface-applied security features include non-reproducible images, such as line art that produces moire patterns when photocopied, photosensitive coatings, and surface decals. Even intricate line art printed on the face of the document may constitute a security feature by virtue of the difficulty with which it is replicated. In all cases, however, the security feature must function well with the security paper selected.

The criteria for an effective document security feature are relatively easy to formulate. Such features should be difficult to replicate to deter potential counterfeiters, or at least to render the fruit of their enterprise less passable to the public. The features should permit ready detection by means available to ordinary holders or users of the final document. For banknotes and other documents on whose authenticity the public at large relies, the features should be discernible and verifiable under ordinary light conditions. Finally, in certain cases, it may be desirable that the security feature afford detection of the movement of large quantities of documents, such as banknotes.

While these criteria may appear straightforward, developing a security feature that reliably satisfies them is not an easy task. Historically, the production of an effective security feature for documents relied upon specialized knowledge or ability possessed by only a tiny segment of the public. Thus, for centuries the rare talents of the master engraver and the specialized knowledge of the printer sufficed to prevent or deter most forgery attempts. Later, the combination of specialized knowledge of several disciplines into the same document became the key to preventing counterfeiting by all but the most determined and able teams of forgers. However, modern advances in color photocopying, scanning, and offset printing technologies have made the production of very convincing counterfeits possible even without such specialized knowledge. To be truly effective against forgery, security features must now be not only difficult to replicate due to the specialized knowledge required for their production, or due to a combination of specialized fields into a single document, but must be very difficult or impossible to duplicate on sophisticated photocopying machines.

Finally, to be useful in producing intrinsically valuable documents, the security paper and the security feature incorporated in or on the paper must together be capable of transformation into a aesthetically pleasing document, at commercial rates and at a reasonable cost. The governmental, quasi-governmental, and corporate entities that generally issue such documents demand no less than that their documents reflect the character of their issuer and inspire the utmost confidence by both their functionality and their appearance. Thus effective security papers and security features should offer a wide degree of freedom in the design and execution of the final document.

A number of approaches have been proposed in the past for providing a security paper with effective security features. May of the proposed security papers incorporate security features during the paper-making process, that is, on the papermaking machine while the web of the security paper is being formed. Such papers make use of security features such as water marks, security threads, security tapes with or without microtext, confetti, and other devices embedded in the paper prior to completion of the paper-making operation. However, such security papers generally cannot provide a security feature covering the

entire surface of the security paper due to the need to drain moisture from the paper during final processing. In addition, security features such as confetti are not generally localized within the security paper, as is required in many applications. Although security features such as security tapes and threads may be localized in the papers, these devices can cause difficulties in printing, sheeting and other process steps due to the increased local thickness in the paper resulting from their presence.

Another approach to incorporating a security feature in security paper is to laminate finished paper sheets to form a composite security paper. One such security paper is described in U.S. Patent no. 5,161,829. In that security paper, at least two paper sheets are laminated to form a security paper with an authentication indicator incorporated in the laminate. The authentication indicator is printed on the inner surface of at least one of the paper sheets prior to lamination, and is detectible in transmitted light, but not in reflected light. However, printing authentication indicators on one of the paper sheets can lead to problems with "show-through," or bleeding of the inks used to print the authentication indicators, through the paper sheets to the surface of the security paper. Furthermore, where printing is done on a thin inner paper sheet, this would usually involve the use of thin inks, resulting in substantial masking of the security feature by surface printing and making the security feature less visible or not visible at all. Moreover, the use of paper sheets in the laminate does not result in a composite security paper having physical properties beyond those attainable with more conventional single-web papers. In particular, properties related to circulation life, including folding endurance and tearing strength, are in no way enhanced in the resulting laminate.

Another laminated paper product incorporating a security feature is described in Japanese laid-open application no. 322109/88. That product, a card stock formed by laminating two relatively thick paper sheets on either side of a synthetic substrate, incorporates machine-readable marks on the substrate material. The marks, such as universal product codes, are printed in inks that do not permit transmission of light of near infrared wavelengths. Other marks are printed on the substrate in near infrared-transmitting inks. The resulting marks are not distinguishable in visible light, but can be distinguished and read when the cards are passed between a light emitting diode of the proper wavelength and a photoreceptor. However, the cards described are not intended, nor are they suitable for use as security paper, due to the stiffness and low folding endurance inevitably resulting from their physical structure. Moreover, the security feature taught in this document is not readily discernible to a holder under ordinary light conditions. On the contrary, the marks printed on the substrate cannot be discriminated in visible light and are thus of no use to the ordinary holder without special detection means.

The present invention is directed to overcoming or minimizing the drawbacks of the existing techniques set forth above, and to providing a security paper for documents with intrinsic value having security features that can be readily distinguished by the public, but that are not susceptible to replication by counterfeiters. The invention provides a security feature in the form of a color mark, not obtainable by prior art processes or in known security papers. Furthermore, the invention offers a security paper of substantially uniform thickness, facilitating conversion operations such as printing and sheeting, and allowing the paper to perform well in high speed sorters and automatic teller machines. Moreover, the invention provides security features which may be localized where desired. The security feature may be employed alone or in conjunction with known security devices.

In accordance with one aspect of the invention, there is provided a security paper that includes a resinous substrate sheet having two faces. Indicia are disposed on one of the faces of the resinous substrate sheet, and two paper sheets are permanently laminated on each of the faces of the substrate sheet. In the resulting laminate, the indicia on the substrate sheet are substantially undetectable when viewed in reflected light and are apparent through the security paper when viewed in transmitted light within the visible spectrum.

In accordance with another aspect of the present invention, there is provided a laminated security paper having a resinous substrate layer with a first and a second face. A layer of color indicia is disposed on the first face of the substrate layer. The layer of color indicia includes at least one region having a color corresponding to a wavelength of light from 380 to 720 nanometers. A first adhesive layer is disposed on the first face of the substrate layer over the layer of color indicia. A second layer of adhesive is disposed on the second face of the substrate layer. A first layer of paper is disposed over the first adhesive layer and fixed permanently to the substrate layer and to the layer of color indicia by the first adhesive layer, while a second layer of paper is disposed over the second adhesive layer and permanently fixed to the substrate layer by the second adhesive layer.

In accordance with a further aspect of the invention, there is provided a security document that includes a resinous substrate sheet having two faces. Indicia are disposed on one of the faces of the substrate sheet. The security document also includes two paper sheets, each having an inner face and an outer face. One of

the paper sheets is permanently laminated on each of the faces of the substrate sheet by means of an adhesive applied between the faces of the substrate sheet and the inner faces of the paper sheets. A set of indicia is printed on at least one of the outer faces of the paper sheets, whereby the indicia on the substrate sheet cooperate with the set of indicia printed on the outer face of the paper sheet to form a total image when viewed in transmitted light.

In accordance with still another aspect of the present invention, there is provided a method for manufacturing a security paper including a first step of defining a graphic design in color. The graphic design is then printed on a resinous substrate sheet as a substantially transparent color image. The resinous substrate sheet is then laminated between two thin paper sheets by means of a suitable adhesive.

The present invention will become more fully understood from the following detailed description, taken in conjunction with the accompanying drawings, wherein like reference numerals refer to like parts, in which:

**FIG. 1** is a partial vertical section of a laminated security paper in accordance with the present invention, depicting the various layers of the laminate and their interaction in transmitted light;

**FIG. 2** is a partial vertical section of a laminated security paper in accordance with the invention, illustrating the reflection, absorption, and transmission of light incident on one surface of the paper;

**FIG. 3** is a perspective view of a banknote incorporating the security paper in accordance with the invention, with portions of the paper removed to illustrate certain cooperative effects possible between indicia on the various sheets or layers of the paper; and

**FIG. 4** is a perspective view of a banknote incorporating the security paper of the invention, with portions of the paper removed to show a further cooperative effect possible between the indicia.

While the invention is susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and will be described in detail herein. However, it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

Turning now to the drawings and referring to Fig. 1, a laminated security paper, designated generally by the reference numeral 10, is depicted in partial vertical section to illustrate the layers of which the paper 10 is comprised. As depicted in Fig. 1, the security paper 10 is intended ultimately to be incorporated in a final document 11, such as a banknote, stock certificate, check, passport, or any other intrinsically valuable document for which authenticity ensuring features are desirable. It should be noted that the present security paper 10 may also find applications in other areas as well, including corporate letterhead, paper for occasional invitations, and the like. The security paper 10 includes a first paper sheet 12, a substrate sheet 14, and a second paper sheet 16. Indicia, designated collectively by the reference numeral 18, are disposed on one surface or face of the substrate sheet 14 prior to lamination of the three sheets 12, 14, 16. A set of indicia 20, 22 may be disposed on the outer faces 24, 26 of either, or both of the two paper sheets 12, 16, as illustrated in Fig. 1. Although reference is made to the indicia 18, 20, 22 in the plural throughout the present description and in the claims, it should be understood that the "indicia" 18, 20, 22 may, in fact, constitute a single "indicium," or image, on the substrate sheet 14 or on either of the paper sheets 12, 16. As will be more fully described below, the indicia 18 on the substrate sheet 14 are preferably designed and disposed on the substrate sheet 14 in such a way as to register and cooperate with some or all of the set or sets of indicia 20, 22 on the paper sheets 12, 16 to form a "total image," such as a color picture, when viewed in transmitted light.

The substrate sheet 14 is preferably a thin, transparent, resinous sheet material. Synthetic materials, such as polyester or polypropylene, or organic resinous materials such as cellophane, may be used for the substrate sheet 14. At present, polyester film material is generally preferred for the substrate sheet 14, such as a polyester film manufactured by E.I. Du Pont de Nemours Company and commercially available under the tradename Mylar. The substrate sheet 14 preferably has a basis weight of between 11.0 and 22.5 grams per square meter, inclusive, and a thickness, or caliper of from 8 to 16 microns. For the best performance, both during later converting operations and during use when incorporated into the laminated security paper 10, it is desirable that the substrate sheet have good dimensional stability, of the order of -1.5% (150 °C, 30 min.). Information on such dimensional stability properties are commonly available from film suppliers. Resinous sheet material meeting these specifications is available commercially in a number of forms, including rolls, from a variety of manufacturers, including E.I. Du Pont de Nemours and Company, Imperial Chemical Industries Plc, Eastman Kodak Company, and 3M.

The paper sheets 12, 16 incorporated in the security paper 10 are preferably high opacity, thin paper. The basis weight, or grammage, of the paper sheets 12, 16 is preferably in a range from 19 to 50 grams per square meter, inclusive, with a grammage of about 34 grams per square meter being presently preferred. The thickness of the sheets 12, 16 is preferably included in a range from 0.038 millimeters to

0.050 millimeters, inclusive. The paper sheets 12, 16 may typically include fibrous raw materials, such as cotton, flax, hemp, and wood fibers, or a mixture of such fibers and cellulosic materials, such as wood cellulose. The paper composition presently preferred is a combination of 75% cotton textile fibers and 25% wood cellulose. However, it should be understood that the present security paper 10 is not limited to any particular composition of the paper sheets 12, 16, and in specific applications, the precise composition of the paper sheets 12, 16 may be specified by the eventual issuer of the final document 11. In such cases, additional security features (not shown), such as polyester, rayon, or nylon fibers, fine huing pigment, and certain chemical additives may be incorporated in the paper sheets 12, 16 without substantially affecting the operation of the present color marks as security features.

The opacity of the paper sheets 12, 16 is preferably at least 75%, with opacities in a range of from 75 to 85% providing good results when incorporated in the laminated security paper 10. To obtain such opacity levels in very thin paper, fillers and pigments may be advantageously added during the paper-making operation. Titanium dioxide may be suitably employed as a pigment, along with numerous other substances, such as calcium carbonate. One such titanium dioxide filler is commercially available under the tradename "Titanox" RA 50 from Kronos of Canada.

The paper sheets 12, 16 may be manufactured by any suitable papermaking process. While Fourdrinier machines are generally preferred for the manufacture of the paper sheets 12, 16, due to the high quality paper such machines are capable of producing, other types of machines, such as cylinder machines may also be used. For good wet strength properties, wet strength resins are preferably added during the papermaking process. Such resins include melamineformaldehyde resins, such as resins available from American Cyanamid Company and marketed under the tradename "Parez" resins 607 and 613, or resins available from Hercules Inc. under the tradename Kymene, such as Kymene 450.

Once the substrate indicia 18 have been disposed on the substrate sheet 14, as will be described in greater detail below, the paper sheets 12, 16 are laminated on either face of the substrate sheet 14. To laminate the paper sheets 12, 16 to the substrate sheet 14, a suitable adhesive is applied between the faces of the substrate sheet 14 and the inner surface of the paper sheets 12, 16, and the three sheets 12, 14, 16 are pressed in a laminating machine where the adhesive is cured, as will be described below.

Good adhesion of the paper sheets 12, 16 to the substrate sheet 14 is important to the effectiveness of the security paper 10 in preventing or deterring counterfeiting attempts. Specifically, the laminated security paper 10 should not be susceptible of delamination that could expose the substrate indicia 18 to copying. Any suitable adhesive that, when cured in the laminate, will preclude delamination of the security paper 10 may be used. The adhesive may be a single component adhesive, or a double or multiple component glue. Ultraviolet curing or electron beam curing adhesives may also be employed. Because the substrate indicia 18 should selectively cooperate with the surface indicia 20, 22, without interference from the adhesive, the adhesive is preferably transparent.

The particular adhesive employed should be compatible with the substrate material and with the paper sheets used in the security paper 10. Adhesive manufacturers can generally supply compatibility and suitability information of this type. Depending upon the specific adhesive used, adhesive may be applied either to paper sheets 12, 16, or to the faces of the substrate sheet 14, or to both the paper sheets 12, 16 and the substrate sheet 14. Polyurethane based adhesives are generally preferred, and an adhesive available from Imperial Chemical Industries Plc of Great Britain, and marketed under the tradename Novacote ADH 222 has been employed satisfactorily. The coverage rate of adhesive is preferably within the range of 1.5 to 3.0 grams per square meter, but consumption rates may vary with the type of adhesive used.

The substrate indicia 18 are preferably disposed on the substrate sheet 14 by printing. For this, a graphic design for the indicia 18 is prepared according to any motif desired in the final security document 11. These indicia 18 will often comprise an image, as illustrated in Figs. 3 and 4, but may also include numerals, words, symbols, or any number of these in combination. The indicia 18 may comprise black and white indicia, or may include a full range of visible colors, and may cover the entire surface of the substrate sheet 14, or may extend over only certain regions. Where the indicia 18 on the substrate sheet 14 are intended to cooperate with a set of indicia 20, 22 on either of the paper sheets 12, 16, transparent ink is generally preferred to define the substrate indicia 18. As will be discussed in more detail below, the use of transparent ink permits an observer viewing the security paper 10, or the final document 11, in transmitted light, to perceive a total image in color, created by cooperation of the transparent color indicia 18 on the substrate sheet 14 and the set of indicia 20, 22 on the paper sheet 12, 16.

The substrate indicia 18 may advantageously include a layer of white, or substantially opaque ink above and/or below the transparent color indicia. Such white layers are preferably disposed on both sides of the transparent color ink. These white layers serve two functions. First, they increase the opacity of the security



paper 10, while nevertheless permitting the substrate indicia 18 to be viewed in transmitted light. Secondly, such layers provide an additional security feature in case the security paper 10 is delaminated. While the security paper 10 is extremely resistant to any efforts at delamination, should a paper sheet 12, 16 be removed by counterfeiters attempting to copy the substrate indicia 18, the white layers would preclude reproduction of the color indicia. Any further effort to access the color indicia by removal of the white layer would result in destruction of the color indicia, thwarting the counterfeiting enterprise.

An important aspect of the present security paper 10 is its ability to permit verification of authenticity by any holder and under normal light conditions. Because the human visible spectral range corresponds to light wavelengths from about 380 to 720 nanometers, the inks employed for the substrate indicia 18 are preferably colored, transparent inks, whose colors also correspond to wavelengths within this range.

Other optical effects may be obtained in the security paper 10 by printing some or all of the indicia 18 with fluorescent or phosphorescent inks, such as inks visible under ultraviolet light only. Where ultraviolet inks are used to form part of the substrate indicia 18, indicia printed with such ink may be substantially undetectable under normal conditions, but visible under ultraviolet light. Alternatively, selected portions of the substrate sheet 14 may be made opaque by the use of non-transparent inks, such as non-transparent white ink, or by metallizing, for instance by vapor metal deposition on the surface of the substrate sheet 14. The use of the latter techniques is particularly useful in forming microtext as part of the indicia 18, clearly visible in the security paper 10 only in strong transmitted light, but substantially undetectable in reflected light. Finally, the indicia 18 may advantageously include areas printed with magnetic ink that serves the dual purpose of forming a part of the total image observed in transmitted light and providing an additional security feature detectable by magnetically sensitive detection devices of the type generally known in the art.

The design of the substrate indicia 18 in the security paper 10 permits a great degree of flexibility in the design of the security feature that the final document 11 will incorporate by virtue of the total image mentioned above. For example, the indicia 18 may present areas that resemble watermarks in the final document, but in any visible color or any combination of colors. Alternatively, color indicia 18 may add color detail to a set of indicia 20, 22 provided on one or both outer faces 24, 26 of the paper sheets 12, 16 when viewed in transmitted light. In such cases, at least portions of the surface indicia 20, 22 may also be printed with transparent inks. As will be discussed in greater detail below, where transparent inks are used in both the substrate indicia 18 and surface indicia 20, 22, the color of the substrate indicia 18 will dominate in the total image when viewed in strong transmitted light, whereas the color of the surface indicia 20, 22 alone will be visible when the final document 11 is viewed in reflected light. This is true even where substantially opaque layers are disposed adjacent the color regions, as has been described. Portions of the surface indicia 20, 22 may become substantially invisible when viewed in transmitted light, due to the dominance of the substrate indicia 18. Similarly, substrate indicia 18 in transparent colors may provide a colored background, such as a rainbow or color corporate logo, against which surface printed indicia 20, 22, appear when viewed in transmitted light. For instance, surface indicia 20, 22 may be line art or printed words, such as a company name, not necessarily overlying substrate indicia 18. As will become apparent through the following discussion, although disposed on only one face of the substrate 14, the substrate indicia 18 may register and cooperate with surface indicia 20, 22 on either of the paper sheets 12, 16, or on both paper sheets.

Figs. 1 and 2 illustrate in greater detail the operation of the various layers of the security paper 10 under reflected and transmitted light regimes. As shown in Figs. 1 and 2, the laminated security paper 10 includes a substrate layer 14, a layer of indicia 18 disposed on one of the faces of the substrate layer 14, a first paper layer 12 permanently fixed over the layer of indicia 18, and a second paper layer 16 permanently fixed over the other face of the substrate layer 14. Adhesive layers 28, 30 serve to bind the substrate layer 14 to the paper layers 12, 16. As described above, in the final document 11 incorporating the security paper 10, surface indicia 20, 22 are printed on the exposed surface 24, 26 of either or both of the paper layers 12, 16.

Light, such as white light including components of wavelengths between about 380 and 720 nanometers, incident on the security paper 10 is either transmitted through the paper, absorbed by the paper, or reflected. As represented by the line 32 in Fig. 2, transmitted light passes through all layers of the security paper 10 and emerges from the surface 24 of the paper opposite the surface 26 through which the light entered. Absorbed light, represented by the line 34 in Fig. 2, penetrates into the security paper 10, but is dispersed and absorbed by the paper fibers, and by any pigments and fillers included in the paper to increase opacity. Reflected light, represented in Fig. 2 by the line 36, does not penetrate into the security paper 10, but rebounds from the surface 26 of the paper and from any indicia 22 applied to the surface 26.

In the security paper 10 as illustrated in Fig. 2, an observer situated on the same side of the paper as a light source (not shown) from which the lines 32, 34, 36 might originate, perceives only the reflected light 36, whereas an observer on the opposite side of the security paper 10 from the light source sees transmitted light 32. Because absorbed light 34 is effectively trapped in the layers of the security paper 10, it is not perceived by either observer. Due to the high opacity of the paper layers 12, 16 in the present security paper 10, virtually all light penetrating into the security paper 10 is either transmitted through the layers of the security paper 10, or absorbed in the paper layers 12, 16. Because practically no light reflects from the substrate indicia 18, the indicia 18 remain virtually imperceptible to an observer examining the security paper 10 in reflected light, and photoreproduction of the substrate indicia 18 of the quality required for counterfeiting is impossible.

The cooperation among the substrate indicia 18 and the surface indicia 20, 22 in transmitted light is illustrated in Fig. 1 and may be summarized as follows. Some amount of the light 38 incident on the security paper 10 penetrates into the paper through the surface 26 and is transmitted through the paper layer 16, the adhesive layer 30, and the substrate layer 14 to impact the substrate indicia 18. Regions 40, 42, 44, 46, 48 of transparent color in the substrate indicia 18, whose color preferably corresponds to the visible spectral colors having wavelengths of between about 380 and 720 nanometers, absorb certain frequencies of the transmitted light depending upon the color of transparent ink applied to the region, and transmit the remainder of the light. This colored light, represented in Fig. 1 by the shaded areas, is then transmitted through the adhesive layer 28 and the paper layer 12, and emerges from the surface 24 of the security paper 10.

Where the surface indicia 20 comprise no transparent, color indicia, the light emerging from the security paper 10 is of substantially the same color as the region 40, 42, 44, 46, 48 of the substrate indicia 18 through which the light passed. In areas of the surface indicia 20 covered by transparent colored ink, the color of the transmitted light emerging from the paper is primarily that of the substrate regions underlying those areas. The total image observed emerging from the security paper 10 in transmitted light is, therefore, a combination of the image created by the substrate indicia 18 and the surface indicia 20. The stronger the transmitted light 38 incident on the security paper 10, the more the image created by the substrate indicia 18 will tend to dominate over the image created by the surface indicia 20.

Fig. 1 also illustrates how other optical effects may be incorporated into the security paper 10. In lieu of transparent ink, the substrate indicia 18 may comprise regions 54 made opaque by metallizing or by printing with non-transparent ink. Such regions 54 will, of course, effectively stop all transmitted light and thus produce dark regions in the total image perceived. Alternatively, the substrate 14 may be perforated in certain regions 56. Such perforations will become filled with adhesive during the lamination of the various layers of the security paper 10. Because the adhesive is preferably transparent, such perforated regions 56, will transmit light without alteration.

Examples of these cooperative effects are illustrated in Figs. 3 and 4. In Fig. 3, line art comprising the numeral "1" surrounded by a circle (depicted by dashed lines 60) is shown as it might be printed in a lower corner of the outer surface 26 of the paper sheet 16, with a similar encircled numeral "1" being printed in an upper corner of the same surface 26. Colored regions 62 (only one such region shown in Fig. 3) on the substrate sheet 14 are positioned to register with and to overlie the encircled numeral on the paper surface 26. In this arrangement, an observer viewing the outer surface 26 of the final document 11 in reflected light would perceive only the surface indicia 22, 60. When the same document 11 is viewed from the same side, but with a light source located on the opposite side of the document from the observer, the total image perceived by the observer would include the line art 60, colored by the colored regions 62 on the substrate.

A similar arrangement is depicted in Fig. 3 for substrate indicia 18 representing a building and landscape 64. An image 66 printed on the outer surface 24 of the paper sheet 12 may include line art and transparent ink covering some or all of the surface of the image 64. As in the previous example, an observer viewing the document 11 in reflected light would perceive only the image 66 as it appears on the surface 24 of the paper sheet 12, and in the colors printed on the surface 24. Viewing the document 11 in transmitted light, however, the observer would perceive a total image made up of the surface image 66 combined with the substrate image 64. Generally, the greater the intensity of the light used to view the document 11 in the transmitted light regime, the more the substrate image 64 will dominate in the total image perceived by the observer. Where desired, the surface indicia may even become substantially invisible when the document is viewed in transmitted light, due to the dominance of the substrate image 64 in the total image.

Another example of the cooperative effects of the substrate indicia 18 and the surface indicia 20, 22 is illustrated in Fig. 4. As mentioned above, the design and placement of the substrate indicia 18 need not be identical to the design and placement of the surface indicia 20, 22. As shown in Fig. 4, a security feature

incorporated in the security paper 10 may consist in a "ghosting" effect induced by the substrate indicia 68 when viewed in transmitted light. In such cases, the surface indicia 20, 22 need not include line art or other indicia specifically "colored" by the substrate indicia 18 in the total image.

The preferred method for making the security paper 10 will now be described. Because the substrate indicia 18 form a total image in combination with the surface indicia 20, 22 disposed on the security paper 10 in the final document 11, the process for manufacturing the security paper 10 generally begins with the graphic design of all indicia 18, 20, 22 to be printed on the substrate sheet 14 and paper sheets 12, 16. Alternatively, the graphic design for the substrate indicia 18 may be prepared independently of the surface indicia 20, 22, particularly where a standard paper is used by an issuer for a number of different final documents. In either case, the graphic design for the substrate indicia 18 may be prepared by an artist-designer based on any color picture or motif, and may incorporate a full range of visible colors and details. In developing the graphic design, the designer may specify that the design be precisely placed in the security paper 10, or continuously or repetitively printed on the substrate 14. As has been described above, the graphic design for the substrate indicia 18 may include areas of color over which surface indicia 20, 22, including text, will be printed in the final document 11.

In addition to color marks and images, the graphic designer may include in the substrate indicia 18 regions of microtext, portraits or words resembling water marks printed in non-transparent or transparent white ink, and designations printed in fluorescent, phosphorescent, or magnetic ink. Moreover, the design may include perforations in the substrate sheet 14 designed to permit transmitted light to pass unaltered. Metallized regions may also be provided in the design to render the substrate sheet 14 opaque.

The graphic design is processed in order to convert it to a printable form. This is preferably accomplished by electronic color separation. A number of suitable color separation devices are known, including laser analyzers and scanners. Such devices transform the design into pixels, or an array of minute points, containing primary colors. The color separation devices also determine the intensity of the coloration of the pixels, and encode and store the image thus analyzed.

Once the color separation is complete, printing plates or cylinders are prepared for printing the substrate indicia 18 onto one face of the substrate sheet 14. The preferred printing process is rotogravure reproduction. The electronic color separation device is preferably used either for direct cylinder engraving, or for controlling the exposure time of photosensitive material in an indirect process for chemically engraving a rotogravure cylinder. Color synthesis in the printed substrate indicia 18 is accomplished by means of separate rotogravure cylinders for each transparent color, and for any non-transparent or magnetic inks called for in the graphic design. The engraving depth on the rotogravure cylinder is typically in a range of from 3 to 32 microns.

Prior to printing the substrate indicia 18 on the substrate sheet 14, the substrate sheet is preferably given a Corona electric discharge treatment to improve the adherence of the ink to the substrate sheet 14. Corona treatment has also been found to enhance the adherence of the paper sheets 12, 16 that will be laminated on the substrate sheet 14 later in the manufacturing process. This Corona treatment may be carried out in any suitable apparatus readily available commercially for treating thin films, such as treaters available from Sherman Treaters North America Inc.

Optionally, the substrate sheet 14 may be metallized or perforated prior to printing, if called for in the graphic design of the substrate indicia 18. Vapor deposition techniques are preferred for metallizing, and all or a portion of the substrate sheet 14 may be exposed to such deposition. Perforation of the substrate sheet 14 may be used to form text, specific designs, or dotted contours to provide an added security feature. Such perforation is generally carried out on special perforating machines having needles, typically 0.8 to 1.0 millimeters in diameter, that pierce the substrate sheet 14. Where a perforated pattern is designed to cooperate with a printed or metallized area on the substrate sheet 14, the perforating step is preferably carried out after completion of the printing and metallizing steps. Such perforation may be carried out on any suitable machine, such as machines available commercially from Zimmermann & Co. of Berlin, Germany.

The substrate sheet 14 is then printed with the substrate indicia 18, allowing sufficient time between printing stages to allow inks to dry. For printing, as for the other conversion steps in the preparation of the security paper 10, the substrate sheets 14 preferably processed from a roll of resinous film or foil. Processing the substrate material in roll form facilitates the printing and lamination steps, and permits the process to be carried out in production quantities and at a reasonable cost.

The printed substrate sheet 14 is next laminated between two paper sheets 12, 16 to form the security paper 10. In a presently preferred arrangement for laminating the security paper 10, lamination is accomplished in a laminating station consisting of a laminating machine of the type generally known, and a tunnel-type adhesive curing section. Such laminating machines are commercially available from a number

of manufacturers, such as Cerruti of Italy. To form the laminate, two sheets of thin, high opacity paper are fed into the laminating station, preferably from continuous rolls, and the printed substrate sheet 14 is fed into the station between the paper sheets. Adhesive is continuously applied to either the faces of the substrate sheet, or to the surfaces of the paper sheets facing the substrate sheet depending upon the adhesive employed, and the sheets are pressed by nip rolls to form a laminate. The laminate proceeds through the curing section where the adhesive is cured to permanently bond the laminated layers. The precise design of the curing section depends upon the adhesive employed, and the curing conditions recommended by the adhesive manufacturer.

The security paper, exiting from the laminating station as a continuous sheet, may be rolled for later cutting into sheets, or may be sheeted directly as it is produced. Any suitable sheeting device may be employed for this, such as a Pasaban sheeter. The format set on the sheeter will depend upon specifications set by the end user of the security paper 10, and ultimately upon the size of the document to be made from the security paper.

After sheeting, counting and quality control operations may be performed, and the surface indicia 20, 22 may be printed on one or both sides of the security paper 10. The security paper 10 is suitable for intaglio printing, generally preferred for such documents as banknotes, as well as for multicolor offset printing. Where registration between the substrate indicia 18 and the surface indicia 20, 22 is desired, registration marks are preferably incorporated in the substrate indicia 18, and printing on the security paper 10 is registered in generally the same manner as for known water marks.

The foregoing method has been found to produce high quality security paper with physical and optical properties generally comparable to or surpassing those of known security papers. The substrate indicia 18 are substantially undetectable when the security paper 10, or the final document 11, is viewed in reflected light, and clearly visible when viewed in transmitted light. The stability of the colors comprising the substrate indicia 18 is very good, particularly where similar pigments are used to print these indicia 18 as are employed for making banknotes and other security documents. Because the indicia 18 are printed on the substrate sheet 14, and the substrate indicia 18 are separated from the paper sheets 12, 16 by the adhesive layers 28, 30 in the laminated security paper 10, show-through of the substrate indicia 18 is avoided. Moreover, the rate at which the present security paper can be produced exceeds the production rate typical for security papers bearing water marks.

The security paper 10 offers a number of additional security features as compared with known security papers. Due to the practical difficulty in printing on thin resinous films, and in producing very thin, high opacity papers, only a tiny sector of the public will possess the knowledge and machinery needed to replicate the security paper. In addition, the inability to photoreproduce the substrate indicia 18 effectively precludes duplication by photocopying. On the other hand, the total image perceived by observing the final document 11, produced from the security paper 10, in transmitted light within the visible spectrum, provides a simple and effective means by which any holder may verify the authenticity of the document under ordinary light conditions.

Security paper in accordance with the foregoing description was prepared and tested. Results of those tests are summarized in the following four examples and in Table 1, along with results of similar tests on commercially available security papers. Because certain of the tests may have been performed in accordance with non-standard test methodologies, these results are provided for comparative purposes only. Moreover, as will be recognized by those skilled in the art, the results of such tests may not always be reproducible as between testing machines and laboratories.

Tests on the physical and optical properties of the papers was performed in an atmosphere of 50 to 51% humidity and at a temperature of between 22.5 and 23 °C.

Smoothness was tested in accordance with the Bekk method on equipment manufactured by Karl Frank GmbH of Germany, and is reported in seconds (sec). The Bekk method is summarized in test specification number T 479 om-86 of the Technical Association of Pulp and Paper Industry (TAPPI).

Rigidity was tested on a Büchel stiffness tester, and results are reported in millinewtons (mN) of force.

Breaking strength was tested in accordance with the Mullen test method on equipment manufactured by Karl Frank GmbH. The Mullen test method is summarized in test specification number T 403 om-85 of the TAPPI. Results are reported in kilopascals (kPa).

Tearing strength was tested in accordance with the Elmendorf method on equipment manufactured by Lorentzen-Wetters of Sweden on paper samples measuring 65 X 80 millimeters. The Elmendorf method is summarized in test specification number T 414 om-88 of the TAPPI. Results are reported in decanewtons (daN).

Opacity was tested on an Elrepho Datacolor 200 test machine, and results are reported in percent (%).

Finally, the average number of double folds was determined using equipment manufactured by Karl Frank GmbH, with a weight of 1 kilopond. Results are reported in the number of double folds before breaking.

#### 5 EXAMPLE 1

A portrait of a historical figure was used for the motif of a color mark in the form of a line drawing. A polyester substrate sheet, 12 microns thick, available under the tradename Yuborlen, was given a corona treatment on both sides, and the color mark and a color test spectrum were printed in four basic colors by  
10 rotogravure printing. Paper sheets, made of cotton fibers and having a basis weight of 32 g/m<sup>2</sup>, were laminated successively on each side of the substrate sheet using polyurethane based adhesive commercially available under the tradename Novacote ADH 222 from ICI of Great Britain.

#### EXAMPLE 2

15 A color icon was color separated and printed in four colors on the same type of polyester substrate as in example 1. Paper made of hemp fiber, with a basis weight of 30 g/m<sup>2</sup>, was laminated to both sides of the substrate sheet as in the previous example.

#### 20 EXAMPLE 3

The portrait of the historical figure and the icon of the previous two examples were printed by five color rotogravure printing on the same type of substrate used in the previous examples. Paper comprising cotton fibers and wood cellulose, and having a basis weight of 35 g/m<sup>2</sup>, were laminated to both sides of the  
25 substrate sheet using the polyurethane adhesive of the previous examples.

#### EXAMPLE 4

For this example, a polyester film, 12 microns thick and with a basis weight of 16.9 g/m<sup>2</sup>, available  
30 under the tradename Mylar, was used. A multicolor, semihue ornament with a single color text in red, blue and black, and a single color continuous ornament of white, opaque ink, similar to a water mark, were printed the film by rotogravure printing. The printed substrate film was laminated with paper sheets having a basis weight of 36 g/m<sup>2</sup> and consisting of 75% cotton fibers and 25% wood cellulose, using Novacote ADH 222 adhesive as before.

35 As the figures in Table 1 indicate, the security paper produced in the examples exhibits physical and optical properties comparable to, or exceeding commercially available security papers. In particular, the present security paper has excellent strength and durability characteristics, including a greatly enhanced folding endurance. The indicia printed on the substrate is substantially undetectable under reflected light and no show-through is apparent. When viewed in transmitted light within the visible spectrum, the  
40 substrate indicia are clearly visible.

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TABLE 1

	PORTALS [Great Britain]	ARJOMARI [France]	LOUISENTHAL [Germany]	EXAMPLE 1	EXAMPLE 2	EXAMPLE 3	EXAMPLE 4
BASIS WEIGHT [gr/m <sup>2</sup> ]	83	80	82	84	85	88	93
THICKNESS [mm]	0.108	0.100	0.098	0.095	0.096	0.104	0.111
SMOOTHNESS [sec]	9.3	12.6	10.5	10.8	11.3	11.7	12.03
RIGIDITY [mN; 10mm, 15°]	93	100	98.7	70	71	76	74
BREAKING STRENGTH [kPa]	463	425	432	415	420	435	495
TEARING STRENGTH [dan]	12.16	11.87	11.90	12.40	12.47	12.75	13.43
OPACITY [%]	88.19	89.50	85.31	89.85	91.70	88.60	93.23
AVERAGE NO. OF DOUBLE FOLDS	1097	1570	1465	over 2000	over 2000	over 2000	over 2000

## 55 Claims

1. A security paper comprising:  
a resinous substrate sheet having two faces;

indicia disposed on one of said faces of said resinous substrate sheet; and,  
a first and a second paper sheet, said first paper sheet being permanently laminated on one of said faces of said resinous substrate sheet, and said second paper sheet being permanently laminated on the other of said faces of said resinous substrate sheet, whereby said indicia are substantially undetectable when viewed in reflected light and are apparent through said paper sheets when viewed in transmitted light within the visible spectrum.

2. The security paper as set forth in claim 1, wherein said paper sheets are permanently laminated on each of said faces of said substrate sheet by means of an adhesive.
3. The security paper as set forth in claim 1, wherein said indicia include at least one color region, the color of said region corresponding to a wavelength of light of from 380 to 720 nanometers.
4. The security paper as set forth in claim 1, wherein said indicia include a first layer of non-transparent ink, a layer of color indicia including at least one color region disposed on said first layer of non-transparent ink, and a second layer of non-transparent ink disposed over said layer of color indicia.
5. The security paper as set forth in claim 1, wherein at least a portion of said resinous substrate sheet is metallized.
6. The security paper as set forth in claim 1, wherein at least a portion of said resinous substrate sheet is perforated.
7. The security paper as set forth in claim 1, wherein said indicia include microtext.
8. The security paper as set forth in claim 1, wherein said indicia are printed on said resinous substrate sheet.
9. The security paper as set forth in claim 8, wherein said indicia are printed on said resinous substrate sheet in ink selected from the group of inks consisting of transparent ink, fluorescent ink, phosphorescent ink and magnetic ink.
10. The security paper as set forth in claim 8, wherein at least a portion of said indicia is printed on said resinous substrate sheet in ultraviolet ink, said portion of said indicia being substantially undetectable under light within the visible spectrum and visible when viewed under ultraviolet light.
11. The security paper as set forth in claim 8, wherein at least a portion of said indicia is printed in black and white.
12. The security paper as set forth in claim 8, wherein at least a portion of said indicia is printed in color.
13. The security paper as set forth in claim 1, wherein said resinous substrate sheet comprises a resinous material selected from the group consisting of polyester, polypropylene and cellophane.
14. The security paper as set forth in claim 1, wherein said resinous substrate sheet has a basis weight included in a range from 11.0 to 22.5 grams per square meter inclusive.
15. The security paper as set forth in claim 1, wherein each of said paper sheets has a basis weight included in a range from 19 to 50 grams per square meter inclusive, a thickness included in a range from 0.038 to 0.050 millimeters inclusive, and an opacity included in a range from 75 to 85 percent inclusive.
16. The security paper as set forth in claim 1, wherein each of said paper sheets comprise fibrous material selected from the group consisting of wood fibers, cotton fibers, flax fibers, and hemp fibers.
17. A laminated security paper comprising:  
a resinous substrate layer having a first face and a second face;  
a layer of color indicia disposed on said first face of said substrate layer, said color indicia

including at least one region having a color corresponding to a wavelength of light of from 380 to 720 nanometers;

a first layer of adhesive disposed on said first face of said substrate layer, over said layer of color indicia;

5 a second layer of adhesive disposed on said second face of said substrate layer;

a first layer of paper disposed over said first adhesive layer and fixed permanently to said substrate layer and said layer of color indicia by said first adhesive layer; and,

a second layer of paper disposed over said second adhesive layer and fixed permanently to said substrate layer by said second adhesive layer.

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18. The laminated security paper as set forth in claim 17, wherein said layer of color indicia includes a first layer of non-transparent ink, color indicia disposed over said first layer of non-transparent ink, and a second layer of non-transparent ink disposed over said color indicia.

15 19. The laminated security paper as set forth in claim 17, wherein said resinous substrate layer has a basis weight included in a range from 11.0 to 22.5 grams per square meter inclusive, and wherein each of said paper layers has a basis weight included in a range from 19 to 50 grams per square meter inclusive, a thickness included in a range from 0.038 to 0.050 millimeters inclusive, and an opacity included in a range from 75 to 85 percent inclusive.

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20. The laminated security paper as set forth in claim 17, wherein said layer of color indicia is printed on said resinous substrate layer in ink selected from the group of inks consisting of transparent ink, fluorescent ink, phosphorescent ink and magnetic ink.

25 21. A security document comprising:

a resinous substrate sheet having two faces;

indicia disposed on one of said faces of said resinous substrate sheet;

a first and a second paper sheet, each of said paper sheets having an inner face and an outer face, one of said paper sheets being permanently laminated on a respective face of said resinous substrate sheet by means of an adhesive applied between said respective face of said substrate sheet and said inner face of each of said paper sheets; and

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a set of indicia printed on at least one of said outer faces of said paper sheets, whereby said indicia on said substrate sheet cooperate with said set of indicia printed on said outer face of said paper sheet to form a total image when viewed in transmitted light.

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22. The security document as set forth in claim 21, wherein at least a portion of said indicia printed on said outer face of said paper sheet become substantially invisible when viewed in transmitted light.

23. The security document as set forth in claim 21, wherein said set of indicia on said outer face of said paper sheet is in register with said indicia on said substrate sheet.

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24. The security document as set forth in claim 21, wherein said indicia disposed on said resinous substrate sheet include a first layer of non-transparent ink, a layer of color indicia disposed over said first layer of non-transparent ink, and a second layer of non-transparent ink disposed over said layer of color indicia.

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25. A method for manufacturing a security paper comprising the steps of:

defining a graphic design in color;

printing said graphic design on a resinous substrate sheet as a substantially transparent color image; and,

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laminating said printed substrate sheet between two paper sheets by means of an suitable adhesive.

26. The method as set forth in claim 25, comprising the further step of metallizing said resinous substrate sheet prior to said laminating step.

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27. The method as set forth in claim 25, comprising the further step of perforating said resinous substrate sheet prior to said laminating step.



28. The method as set forth in claim 25, comprising the further step of printing a microtext on said resinous substrate sheet prior to said laminating step.

5 29. The method as set forth in claim 25, wherein said graphic design is printed on said substrate sheet in ink selected from the group of inks consisting of transparent ink, fluorescent ink, phosphorescent ink, non-transparent white ink, and magnetic ink.

10 30. The method as set forth in claim 25, wherein said graphic design is printed on said resinous substrate sheet by a rotogravure printing process.

31. The method as set forth in claim 25, wherein said printing step includes printing a first layer of non-transparent ink on said resinous substrate sheet, printing a layer of color indicia over said first layer of non-transparent ink, and printing a second layer of non-transparent ink over said layer of color indicia.

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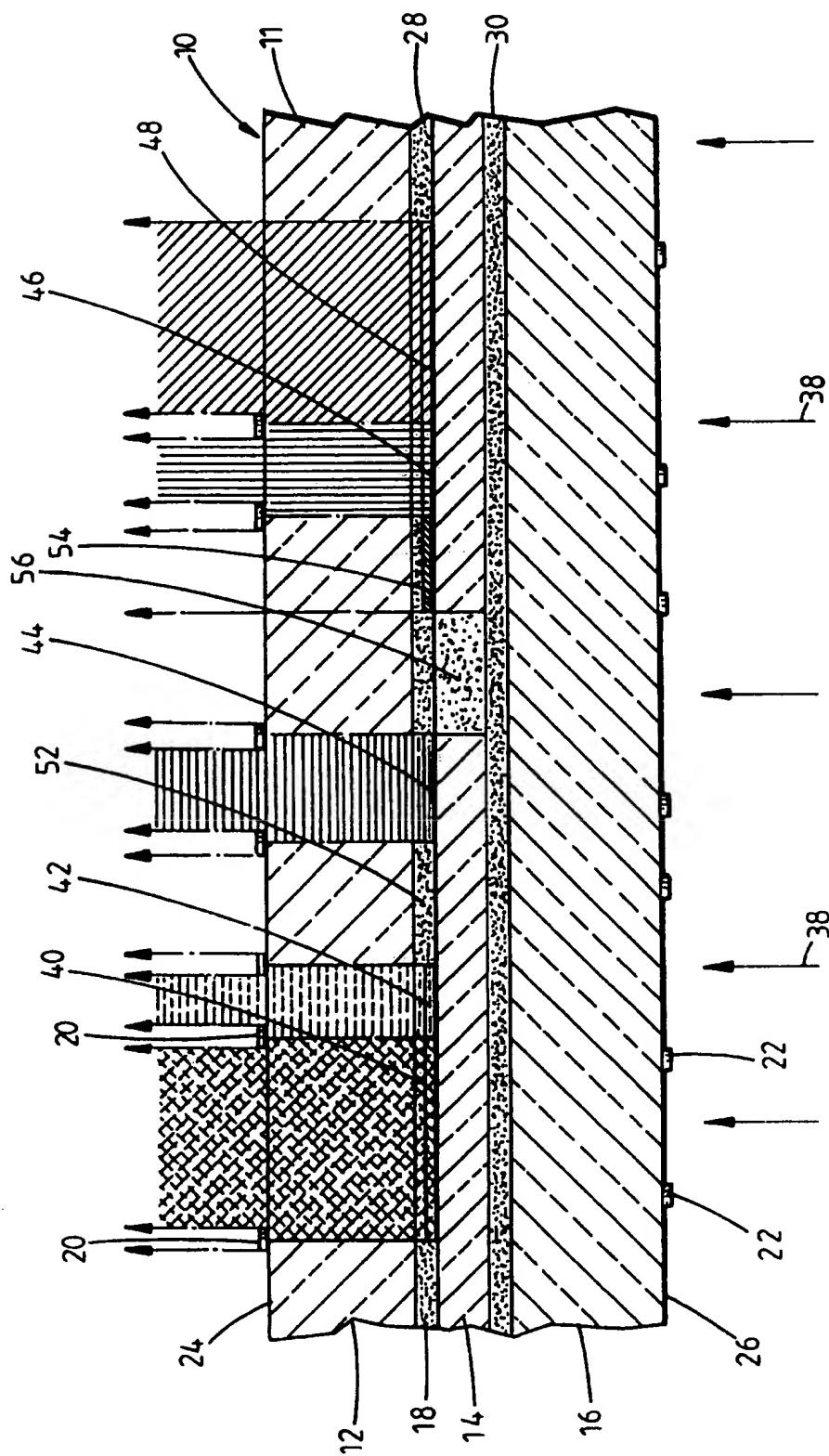
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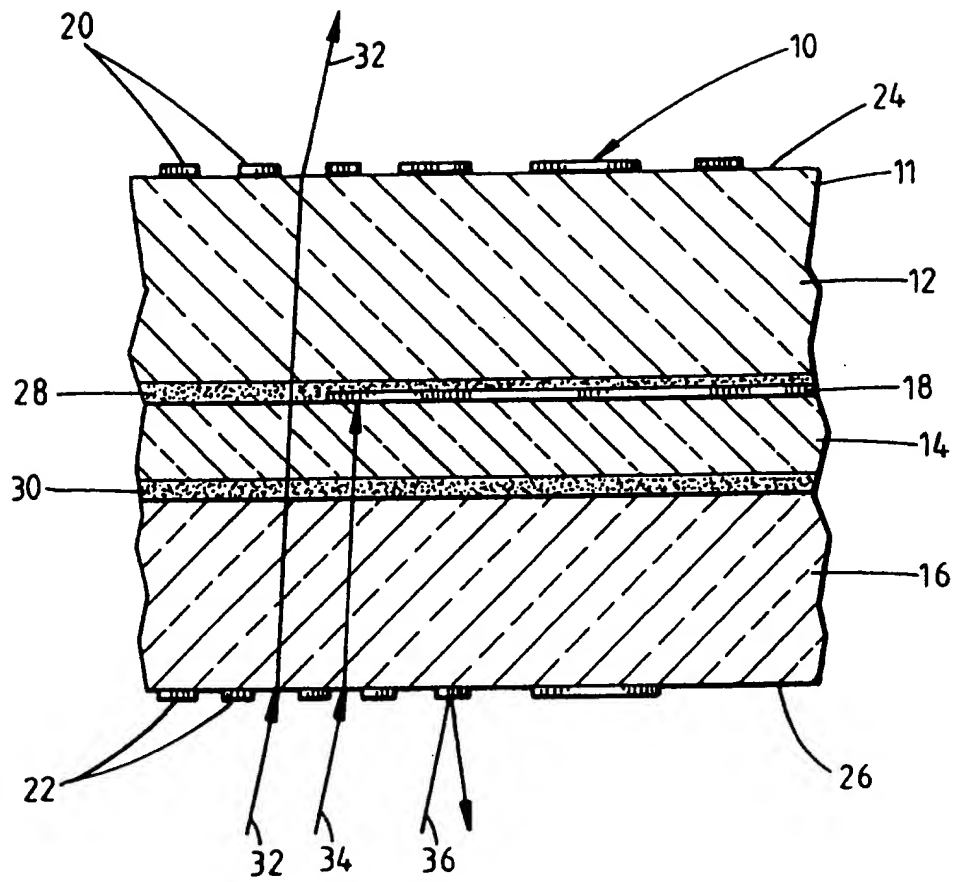
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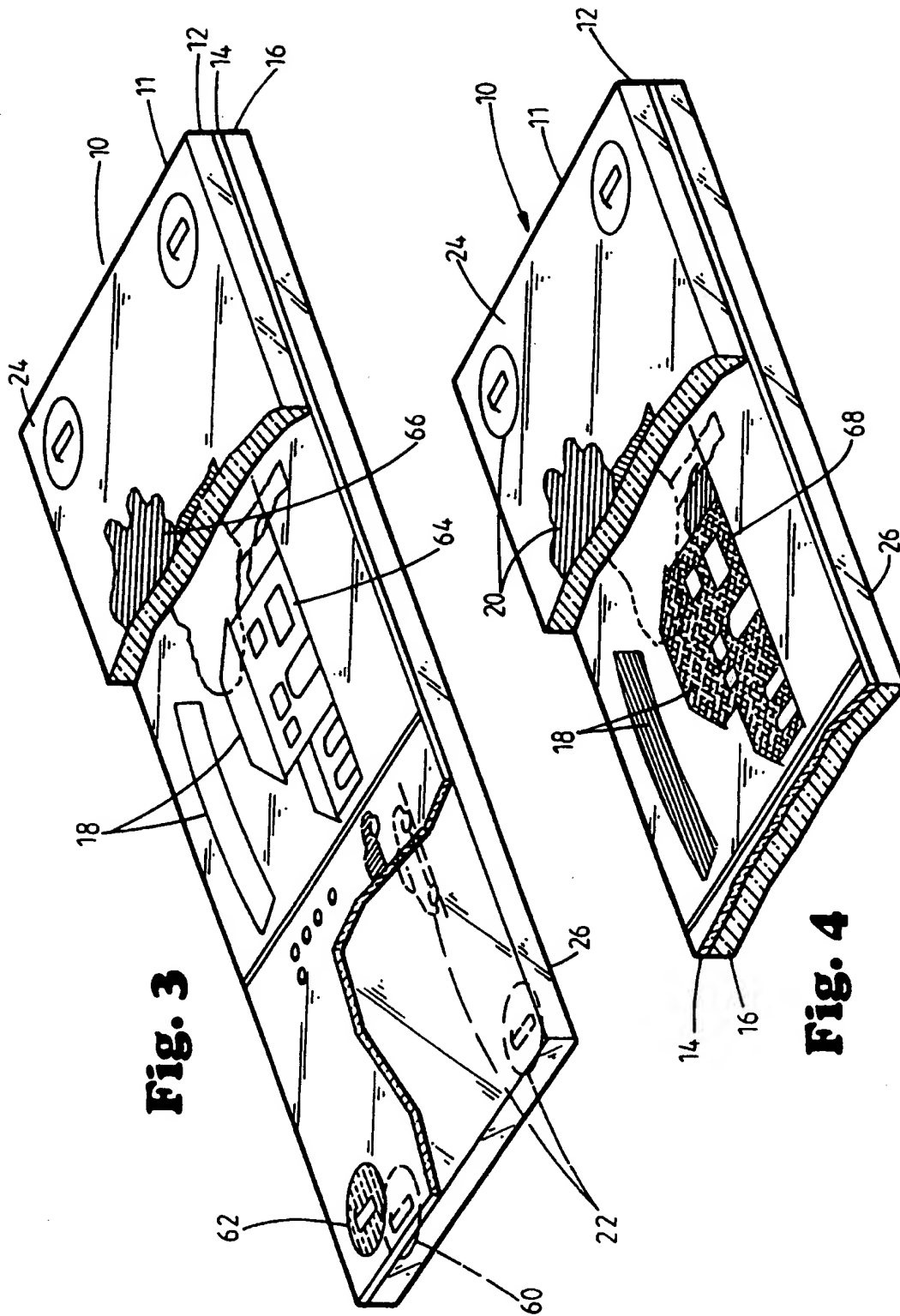
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**Fig. 1**



**Fig. 2**



**Fig. 3**

**Fig. 4**



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## EUROPEAN SEARCH REPORT

Application Number  
EP 93 11 7589

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
Y	EP-A-0 453 131 (JAMES RIVER CORPORATION)	1-5, 7-13, 16-18, 20, 25, 26, 28-31	B32B27/10 D21H27/36 B42D15/00 B41M3/14
A	* column 4, line 6 - line 23; claims *		
D	* column 6, line 1 - line 21 *	15, 19	
	& US-A-5 161 829 (...)		
Y	GB-A-1 353 244 (SODECO)	1-5, 7-13, 16-18, 20, 25, 26, 28-31	
	* page 1, line 9 - line 11; figure 1 *		
	* page 2, line 23 - line 30 *		
Y	EP-A-0 319 157 (PORTALS LIMITED)	1-5, 7-13, 16-18, 20, 25, 26, 28-31	
	* page 2, line 1 - line 6; claims 1-3, 6-9		
	* page 4, line 2 - line 8 *		
	* page 8, line 18 - line 30 *		
Y	US-A-4 941 687 (CRANE)	4, 18, 31	
	* column 1, line 63 - column 2, line 2; claim 1 *		
	* column 2, line 31 - line 56 *		
Y	EP-A-0 388 090 (THE DE LA RUE COMPANY PLC)	11	
	* column 3, line 21 - line 38 *		
	* column 4, line 9 - line 18 *		
	-/--		
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
THE HAGUE		13 July 1994	Pamies Olle, S
CATEGORY OF CITED DOCUMENTS			
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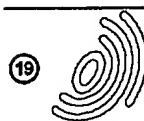


European Patent  
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Application Number  
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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
D,A	PATENT ABSTRACTS OF JAPAN vol. 014, no. 424 (M-1024) 12 September 1990 & JP-A-02 167 771 (SANYO ELECTRIC WORKS LTD.) 28 June 1990 * abstract * -----	1,8-12	
			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
The present search report has been drawn up for all claims			
Place of search	Date of completion of the search	Examiner	
THE HAGUE	13 July 1994	Pamies Olle, S	
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons * : member of the same patent family, corresponding document			



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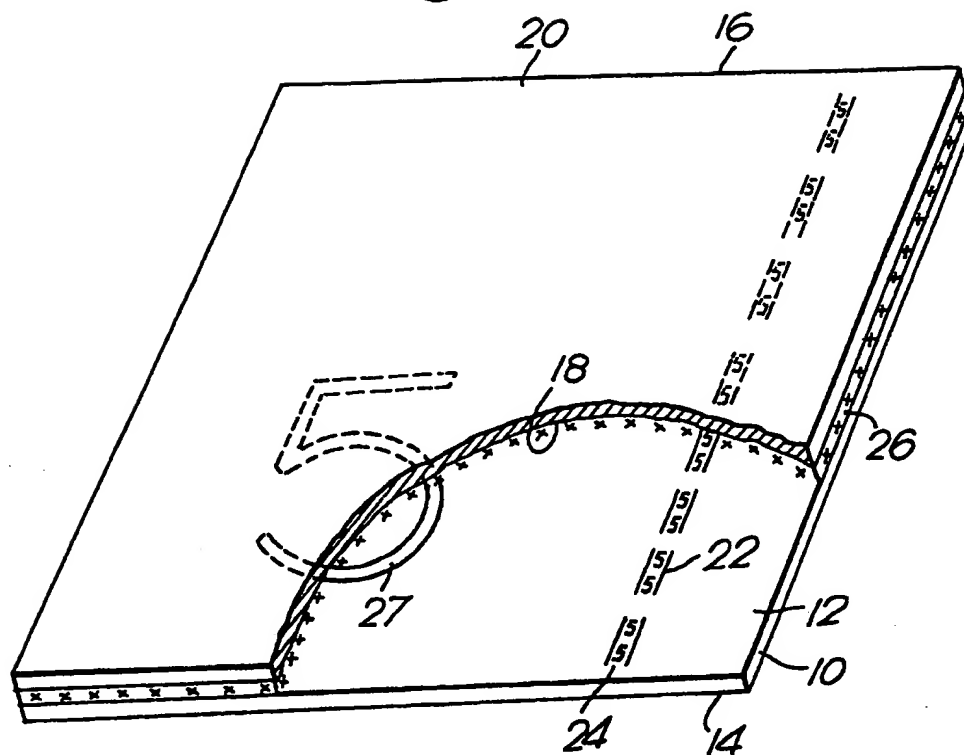
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(54) Security paper and method of manufacturing same.

(57) A security paper comprising a first layer of paper having an inner surface and an outer surface, a second layer of paper having an inner surface and an outer surface, and an authentication indicator disposed on an inner surface of at least one of said layers of paper; the inner surfaces of said layers of paper being affixed relative to each other to form a lamination with said authentication indicator being disposed therebetween and said authentication indicator being substantially imperceptible in said security paper in reflected light of visible wavelength. In a preferred embodiment, the security paper includes two layers of paper each having predetermined mechanical properties, color and optical density. Authentication indicia are printed on the inner surface of at least one layer. The indicia are formed of a chemically, mechanically and thermally stable medium. A chemically, mechanically and thermally stable adhesive permanently adheres the inner surfaces of the layers together. The color and optical density of the layers, the color, color intensity and optical density of the medium and the color and optical density of the adhesive are chosen to render the authentication indicia substantially imperceptible in reflected light but detectable in transmitted light.

EP 0 453 131 A2

*Fig. 1.*





The present invention relates to security paper for use as currency, negotiable instruments, documents representing monetary or property assets, passports, transcripts and any other document which because of its inherent value is subject to forgery, counterfeiting, etc., and relates to the method of manufacturing the security paper. In particular, the invention is directed to security paper having authentication indicia detectable in transmitted light but substantially imperceptible in reflected light.

#### Description of Related Art

A paper entitled "Counterfeiting Trends and Deterrent Measures" authored by the Committee on U. S. Currency, National Materials Advisory Board and published in 1987 discusses various options available to inhibit counterfeiting of currency, particularly in view of advances in high quality reprographic systems and advances in computer publishing capabilities. The paper enumerates various modifications to currency paper and to currency printing techniques which may be used to frustrate counterfeiters having access to modern high technology equipment. Among those considered most effective for currency use were various modifications of the paper substrate such as the incorporation of the security threads, water marks or other substrate modifications which would present authentication indicia in transmitted light but which would be invisible in reflected light.

While the paper mentioned above addressed currency counterfeiting, the need for security paper which would frustrate counterfeiting of other documents such as negotiable instruments, stock and bond certificates, invoices, labels, receipts, passports, property title, transcripts, licenses, lottery tickets, coupons and the like is evident. Modern computers, desktop publishing systems, optical scanners and photocopiers present forgers with a previously unavailable opportunity to reproduce illegally numerous documents having inherent value. The scope of such activities has been reported in "Desktop Forgery", *Forbes*, pp. 246-254 (Nov. 27, 1989), and "Forgery in the Home Office", *Time*, pp. 69-71 (Mar. 26, 1990). These articles indicate the urgent need for a security paper having authentication indicia which cannot be reproduced by instruments using reflected light, such as photocopiers and optical scanners.

For such security paper to effectively inhibit forgery, the authentication indicia must be substantially imperceptible not only to copying instruments using reflected light, but also to the naked eye in ambient reflected light. If authentication indicia were visible to the naked eye in reflected light, they could be placed artificially on the face of a forgery even though they were not copyable by an instrument. Of course, however, by definition the authentication indi-

cia must be easily detectable by other means so that there is a way for the authenticity of the document to be confirmed. One way that this can be achieved, for example, is by rendering the authentication indicia only readily visible in transmitted light.

The subject invention is directed to a security paper having authentication indicia which is not clearly visible to the eye and not reproducible by instruments using reflected light but which is otherwise detectable, e.g. under another condition of radiation, e.g. by being visible or optically readable in transmitted light or magnetically detectable. Or it may be obscured by information on an outer surface and revealed by any attempt to remove said information. The invention is also directed to the method of manufacturing the security paper which overcomes the disadvantages of the prior art processes.

#### SUMMARY OF THE INVENTION

In accordance with the invention, as broadly described herein, a security paper comprises a lamination of at least two layers of paper having inner surfaces permanently affixed together and an authentication indicator disposed e.g. printed, on at least one of said inner surfaces. The layers form a laminate with said authentication indicator being disposed therebetween. The authentication indicator is substantially imperceptible in reflected light but detectable in transmitted light or by other means.

The invention is also directed to a method of manufacturing composite security paper comprising the steps of providing at least two layers of paper each having an inner surface and an outer surface. An authentication indicator is printed on said inner surface of at least one of said layers. Adhesive is applied to at least one of said inner surfaces of said layers and the respective inner surfaces of said layers are adhesively joined to form a lamination. The authentication indicator is provided to be detectable in transmitted light or by other means and substantially imperceptible in reflected light.

#### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

Figure 1 is an enlarged partially cutaway perspective view of security paper manufactured in accordance with the invention;

Figure 2 is a schematic side view of an apparatus for performing the method of the invention;

Figure 3 is an enlarged partially cutaway perspective view of a second embodiment of the present invention wherein the authentication is magneti-

cally detectable; and

Figure 4 is an enlarged partially cutaway perspective view of a third embodiment of the present invention wherein the authentication is a Universal Product Code (UPC).

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference will now be made in detail to the present preferred embodiments of the invention, examples of which are illustrated in the accompanying drawings. The security paper according to one aspect of the invention comprises at least two layers of paper each having an inner surface and an outer surface and predetermined mechanical properties, color and optical properties or characteristics. A number of terms may be used to explain the optical properties or characteristics of the paper and authentication indicator printed thereon. Opacity could be utilized to describe the property wherein the paper has mechanical properties, color and thickness to be substantially impervious to the rays of reflected light while permitting detection of the authentication indicator by utilizing transmitted light. Another term to describe the optical properties or characteristics would be optical density. Optical density is defined as the degree of optical opacity of the paper which relates to the thickness of consistency and impenetrability to thus be substantially impervious to rays of reflected light while permitting detection of the authentication by utilizing transmitted light.

The use of the term reflected light relates to light that impinges upon the paper from overhead in a normal room environment or light exposed on the paper for a predetermined time interval by a photocopy or reproduction machine. The use of the term transmitted light relates to light that projects through the paper by holding the paper up to a light source and looking through the paper. An individual may use transmitted light to detect a paper watermark.

The following discussion of the invention will utilize the term optical density to describe the characteristics of the paper and the authentication indicator.

As embodied herein and depicted in Figure 1, the security paper comprises one layer of paper 10 having an inner surface 12 and an outer surface 14 and another layer of paper 16 having an inner surface 18 and an outer surface 20. Although the invention is described in conjunction with laminations including two layers of paper, the invention contemplates security paper structures incorporating multiple layers of paper and/or nonwoven materials laminated together.

The nature and composition of the paper layers 10, 16 may be varied depending upon the ultimate intended use of the security paper. The layers may be substantially identical if desired or they may be different, e.g. having different compositions. Thus, each

layer 10, 16 may have identical mechanical properties, basis weight, color and optical density or the characteristics e.g. mechanical properties, color, optical density, of each layer may be different to achieve desired or necessary effects in the resulting security paper lamination. For example, in a security paper having a basis weight of 50 pounds per ream (3000 ft<sup>2</sup>), each layer 10, 16 may have a basis weight of approximately 25 pounds per ream or one layer could have a basis weight of 40 pounds per ream and the other a basis weight of 10 pounds per ream.

The characteristics of each layer of paper 10, 16, such as fold strength, tensile strength, wet tensile strength, tear strength, burst strength, optical density, and color properties will be determined based upon the desired characteristics of the resulting laminated security paper and, as for optical density and color properties, upon the desired optical relationship with the other components of the security paper.

One or both of layers 10, 16 may be formed of lignocellulosic fiber, cotton fiber, flax fiber or other known natural and synthetic fibers and combinations thereof.

In an example of security paper of the invention intended for use as currency, each layer of paper 10, 16 is formed from a blend of cotton and linen fibers, and is size pressed on the outer surfaces 14, 20 to provide printability and feel. In this example, inner surfaces 12, 18 are not size coated, although the inner surfaces could be size coated where the selected sizing does not interfere with adhesive bonding of the layers to form the laminate.

Any known process for forming and finishing paper sheets may be used to make layers 10, 16. Preferably, a wet fibrous web is formed from a fiber slurry, dried and pressed, to form the web of paper which is eventually cut into sheets. The slurry or furnish may include a variety of additives designed to adjust the mechanical properties, the color, the optical density, the light scattering characteristics, or the light absorption characteristics of the web. Any combinations of such additives may be used to achieve the desired end result which will be dictated by the intended use of the resulting laminated security paper and the characteristics of the other components of the lamination. Additives such as dyes, pigments, sizing, retention aids, fillers, wet strength enhancers and the like may be used to adjust the mechanical characteristics, the color and the light transmission, absorption and reflection of the web.

In the example, wet or dried lap pulp comprising about 25% bleached flax fiber and the remainder cooked rags is conveyed to a standard hydropulper and slushed to approximately 6 to 7% solids. The pH may be adjusted as appropriate. The pulps are subsequently transferred to a storage chest where they are reduced to between about 3% and about 5% solids.

The pulps are then refined to promote fiber hydration and to impart fibrillation. Various types of refining may be used. In this example, the pulp is refined in a series of cycles. The refining steps will vary depending upon the fiber involved, the desired end strength of the paper, and other known factors affected by refining. It is known, for example, that highly refining pulp increases the light transmission characteristics of the resulting paper. In order to obtain the required optical density, pulp refining, among other processing steps, must be adjusted to achieve the desired light scattering and transmission characteristics without compromising the necessary paper strength.

Manufacture of the paper webs for the example discussed above proceeds on a paper machine. Wet strength additive is added to the furnish to improve durability and launderability of the product. Sufficient water is added to the furnish to ensure good formation on the wire. Using standard papermaking techniques, the webs of paper 10, 16 are formed at a basis weight approximately half that of the intended security paper laminate.

The paper web may be size press treated on one or both surfaces with treatments that include binders, fillers, viscosifiers, plasticizers, pH modifiers and the like to further enhance the paper properties. In the example, the outer surface of each layer is press sized; preferably the outer surface of the layer is the wire side. The size press formulation in this example contains a binder such as animal glue, a plasticizer such as glycerine or urea, and a cross-linker such as melamine formaldehyde.

In accordance with the invention, authentication indicia are printed on the inner surface of at least one layer of paper, the indicia being formed of a chemically, mechanically and thermally stable medium having a predetermined color, color intensity and optical density. As depicted in Figure 1, an authentication indicator 24 includes indicia 22 disposed on an inner side 12 of sheet 10. The indicia 22 is printed in chemically, mechanically and thermally stable ink having a predetermined color, color intensity and optical density.

While the term indicia is plural, and indeed in most instances more than one indication of authenticity would be used, the term as used herein is intended to encompass a single indication of authenticity where the context permits. The invention contemplates any indicia which can be printed on the surface of a finished layer of paper, preferably in ink, although other media may be used, and preferably printed by a rotating cylindrical printing plate for economy and efficiency of production.

The indicia may take the form of graphics, such as the large numeral 27 depicted in Figure 1, pictures, logos, stripes, optically readable characters, e.g. bar codes, as illustrated in Figure 4, and other desirable

patterns and shapes. The indicia may include a security stripe, with or without micro-characters, which is disposed in a predetermined spaced relation to at least one edge of the security paper. Ink may be used to print half-tone graphics which when viewed in transmitted light may have the appearance of a watermark. Indeed, in combination with other indicia printed in ink or other similar media, graphics similar to watermarks may be printed on the paper sheet by using oil or other chemical treatments as the printing medium. The printing medium may be or include materials which can be magnetically sensed or which fluoresce in the presence of ultraviolet light.

Various combinations of indicia may be printed either in one printing operation using a single plate or in a series of printing operations. The invention contemplates printing indicia on the inner surfaces of both layers of paper which when laminated together may overlap to create unique graphic patterns or may be spaced to provide two or more indicia in the lamination.

The media used to print the indicia must be sufficiently stable to resist chemical, mechanical and thermal degradation. These characteristics will depend in part on the intended use of the resulting security paper laminate. Documents such as currency, negotiable instruments, receipts, etc. which are subjected to wide use, frequent folding, spindling or other mutilation require a media which will resist such mechanical forces. Of course, to inhibit forgery, the media must resist thermal and chemical degradation. This resistance is considered sufficient if it is the same or better than the resistance of the paper to the same degradation. In such event, efforts to degrade or affect the media will sufficiently degrade the paper to make the tampering efforts evident.

The preferred medium is ink. The ink selected must have the required degradation characteristics and must be capable of being printed using the desired apparatus. The selected ink, or other media, must also be chemically and mechanically compatible with the selected paper and adhesive. The color, color intensity and optical density of the ink, or other media, will be selected as described below to achieve the desired chromatic and light absorption, transmission and reflection characteristics. Preferably, the viscosity and the color, the intensity and the optical density of the selected ink, or other media, are adjustable during the printing operation to achieve the desired characteristics.

In the example discussed above, the ink used was Pernaprint Ink available from the ink division of the James River Paper Company. This particular ink, which incorporates a proprietary binder system of James River, has chemical, mechanical and thermal resistance properties specifically designed for packaging of chemical specialties. Since this ink is normally formulated for surface printing applications, its

performance for use in making a lamination for security paper can be improved, as will be understood by those skilled in the art, by eliminating slip additives or lubricants such as wax or silicones or similar components commonly added to provide slip and scuff resistance, but which would tend to inhibit adhesion.

In accordance with the invention, the security paper comprises chemically, mechanically and thermally resistant adhesive permanently adhering the inner surfaces of the layers together, the adhesive having a predetermined color and optical density. As depicted in Figure 1, adhesive 26 is disposed between adjacent inner surfaces 12, 18 of layers 10, 16. As with the printing medium, the adhesive must be chemically, mechanically and thermally stable to resist degradation. The adhesive should have sufficient resistance to degradation such that any effort to chemically solubilize the adhesive, mechanically break the adhesive, thermally separate the adhesive, or otherwise de-laminate the security paper would sufficiently degrade the security paper to make the tampering efforts evident. Adhesives meeting these criteria, if properly applied, will permanently adhere the paper layers in the security paper laminate as that term is used herein. The adhesive also must be compatible with the paper and printing medium and must be capable of efficient application in the selected apparatus.

While any adhesive meeting the performance criteria may be used, preferred adhesives have chemically inert backbones and are cross-linkable to provide thermal resistance. The adhesive should have sufficient cross-link density to provide chemical and thermal resistance and should be flexible enough to avoid a brittle laminate. The adhesive may be selected from the group including carboxylated polymers, thermosetting acrylics, or N-methylol acrylamide interpolymers. The adhesive may be a thermosetting acrylic composition based on acrylic copolymers cross-linked with epoxies, melamine formaldehydes, isocyanates, or carboxylic acids; or a thermosetting composition based on acrylamide interpolymers with formaldehyde; or a carboxylated styrene butadiene polymer cross-linkable with melamine formaldehyde. Specific adhesives fitting this criteria can be formulated using Airflex 420, Airflex 421 or Vinac 281 from Air Products Company, S303-283C from Bostik, 2R001 from Swift Company, WS3352RB or 42-2151 from National Starch, 216 from Goodyear, Gen-Flo 3070 from Gen Corp., or Tylac 68414 and 68067 from Reichold Corp.

Additives may be added to the adhesive to achieve the desired color and optical density characteristics. For example, dyes or pigments may be added to affect the light transmission, reflection and absorption characteristics of the adhesive.

In accordance with the invention, the color and optical density of the layers, the color, color intensity

and optical density of the medium, and the color and optical density of the adhesive combine to render the authentication indicia substantially optically imperceptible in reflected light and optically perceptible in transmitted light. The color and optical density of layers 10, 16, the color, color intensity and optical density of the ink used to print the authentication indicator 24 by using indicia 22 and the color and optical density of adhesive 26 are all selected to combine to render the authentication indicia not readily visible in reflected light, such as visible ambient light or the reflected light used in photocopiers and optical scanners.

This embodiment of the invention is directed to a balancing of the different light characteristics of the elements of the security paper laminate to render the indicia imperceptible in reflected light and detectable in transmitted light. Light incident on a paper laminate is subject to reflection, absorption and transmission. The greater the reflection and absorption, the more opaque the laminate appears. Reflection consists of surface reflection and diffuse reflection. Surface reflection may be adjusted by altering the exterior surface of the laminate. Diffuse reflection affects that portion of incident light which is not surface reflected but enters the paper laminate and is scattered due to refraction and internal reflection. Scattering depends upon the number of times light must pass from one refractive index to another. Scattering also affects light transmission. If light is transmitted through an object without scattering, the object generally appears transparent. Paper generally diffusely transmits light due to scattering; such diffusely transmitted light makes it appear translucent. Absorbed light is converted by the material into another form of energy. Some materials absorb light of only certain wavelengths, reflecting the remainder. In the visible light spectrum, materials which do not absorb light appear white or colorless as if transparent whereas objects which absorb all light in the visible spectrum appear gray or black. In between these extremes, materials appear to have colors within the visible spectrum depending upon the wavelength absorbed and reflected.

These basic principles are applied to achieve the desired combination of light characteristics which render the indicia in the security paper laminate imperceptible in reflected light but perceptible in transmitted light. The structure of the paper layers, for example, is adjusted to enhance scattering of diffuse reflection. The chemical contents of the paper layers are adjusted to affect light absorption and diffuse transmission. For example, dyes or pigments may be added to the paper to absorb certain wavelengths of visible light resulting in the appearance of a particular color. In one example, the paper layers may have an optical density of up to 80% and  $L^*$ ,  $a^*$ , and  $b^*$  values of 89.3, -3.0 and 11.9, respectively.

The same principles apply to the selection of the

adhesive and the indicia medium. The color, color intensity and optical density of the medium and the color and optical density of the adhesive are selected to balance with the paper layers to achieve the desired effect. In the example, the medium is ink formulated to have high optical density in transmitted light and its  $L^*$ ,  $a^*$  and  $b^*$  values closely matched to those of the paper layers. The selected adhesive may also have similar  $L^*$ ,  $a^*$  and  $b^*$  values or the values may be adjusted, such as for example by adding dyes or pigments, to compensate for color differences between the paper and the medium.

Applying these principles with a variety of combinations of paper, adhesive and indicia media provides great flexibility in generating security paper laminates designed for particular uses and for specific authentication systems. The principles may be used to balance the optical characteristics of the security laminate with the optical characteristics of a medium printed in areas on the outer surface of the security laminate. In some documents, such as negotiable instruments, certain exterior surface areas are designated for placement of critical information, such as the amount of a check. With proper positioning of an indicia on the inner surface of a layer to correspond with the critical area on the outer surface of the laminate and proper selection of the medium for that indicia and the medium used to cover the outer areas of the laminate, the indicia would be substantially imperceptible in reflected light. However, any attempt to remove critical information, either chemically or mechanically, could result in removal of the medium on the outer surface rendering the indicia visible. Even in this example, the indicia could be perceptible in transmitted light.

A presently preferred method of manufacturing the security paper in accordance with the invention comprises the steps of providing at least two webs of paper each having inner and outer surfaces and predetermined mechanical properties, color and optical density; printing authentication indicia on the inner surface of at least one web in a chemically, mechanically and thermally stable medium having predetermined color, color intensity and optical density; applying chemically, mechanically and thermally stable adhesive to the inner surface of at least one web; adhesively joining the respective inner surfaces of the sheets in registration to form a lamination and curing the lamination.

As discussed above, the paper webs may be made using standard paper making techniques including forming a wet fibrous web from a fiber slurry and drying, pressing and curing the web to form the paper layers which are thereafter cut into sheets. The fiber slurry may include lignocellulosic, cotton, flax or other natural or synthetic fibers and various additives designed to effect the mechanical and optical properties of the paper. Also, as discussed above, a size

coating may be placed on one or both sides of one or more webs.

A presently preferred apparatus for forming the security paper lamination of the invention is depicted in Figure 2. Roll 30 of paper is disposed to be continuously fed in a machine direction into coater-laminator apparatus 32. Web 10' which provides paper layer 10 in the product laminate is wound on roll 30 with inner surface 12' being positioned inwardly. Web 10' is conveyed to a central impression drum 34 and then to a nip 36 defined between a printing cylinder 38 and the central impression drum 34. The inner surface 12' is disposed adjacent to the printing cylinder 38. A printing medium, such as ink, is conveyed from reservoir 40 by anilox roll 42 to printing cylinder 38. The viscosity of the ink in reservoir 40 is preferably adjusted to a printable viscosity by adding water. The concentration of dyes and/or pigments is adjusted to achieve the desired color intensity and optical density. Anilox roll 42 preferably is etched at about 200 Q to about 360 Q.

The surface of printing cylinder 38 is designed to reproduce the desired authentication indicia onto the inner surface 12' of web 100 in a manner which compensates for paper shrinkage and in a predetermined position with respect to the cross machine edges of web 10'. The web 10' is guided through the nip 36 to assure accurate placement of the authentication indicia. After printing, web 100 may be conveyed over platen heaters 44 to dry the printing.

Preferably, a second web 16', which provides paper layer 16 in the product laminate, is unwound from another roll (not shown) and simultaneously fed into apparatus 32 from an opposite direction into nip 46 defined between an anilox roll 48 and backing roll 52. Web 16' is conveyed such that an inner surface 18' is disposed adjacent to the anilox roll 48. A selected adhesive is contained in reservoir 50 and conveyed to the anilox roll 48. Anilox roll 48 preferably has an etch pattern of about 50 Q to about 95 Q and transfers adhesive at a rate of about 2 or 3 to about 12 pounds, preferably about 3 to about 7 pounds and more preferably about 4 to about 6 pounds, per ream (3000ft<sup>2</sup>) of web 16', depending upon the end use requirements for the security paper laminate.

Web 16' is joined with web 10' at nip 54 defined between backing roll 52 and impression drum 34 in such a manner as to place the inner surfaces 12', 18' in contiguous registration. Preferably, the cross machine dimension of web 10' is slightly larger than that of web 16' so that web 10' extends beyond the opposed edges of the lamination to receive excess adhesive squeezed out during the joining step and to prevent adhesive from being deposited on the impression drum 34.

The formed wet lamination 56 is then conveyed to a dryer 58 and thereafter to a heated combining drum (not shown) where final lamination is effected by heat

and pressure. The combining drum is heated at a predetermined temperature and imposes a laminating pressure. This final lamination step initiates cross-linking of the adhesive and irons out wrinkles in the lamination 56. After the combining drum, lamination 56 may be passed over other heated rolls and subsequently rewound. Lamination 56 may be dampened prior to rewinding to replace moisture lost during the lamination process. If the cure mechanism of the selected adhesive has a low reaction rate, the rolls of lamination may be post cured in a heated chamber.

After the adhesive has sufficiently cured for the lamination to be handled, the lamination may be slit to the finished width on a rewinder incorporating conventional electronic eye technology to ensure that the slitter blades slit the paper in registration with the authentication indicia. Thereafter, the slit rolls may be sheeted on a standard mill cutter to desired lengths. If the authentication indicia does not have to be registered in the machine direction, the sheeting step is not particularly critical. On the other hand, if the authentication indicia includes graphics which are not continuous in the machine direction, the sheeting step will require registration control to ensure print to sheet registration.

While the depicted apparatus involves printing on one surface of one layer and applying adhesive on one surface of the other layer, other alternative apparatus may be used permitting printing of authentication indicia on the inner surfaces of both sheets and applying adhesive to the inner surfaces of both layers. The latter may be appropriate where a two-part adhesive is used. Indeed, apparatus could be used which permits simultaneous printing on the outer surfaces of the paper sheets during the lamination process or sequential printing on the outer surface of the security paper after lamination. Printing of the authentication indicia may also be accomplished by means other than an inline printing process, such as, for example, offset lithograph printing or by flexographic or rotogravure printing. Also, the adhesive may be applied by many other known methods such as spraying, extrusion, flexographically, by rotogravure and by padding in addition to roll coating.

Figure 3 is another embodiment of the present invention wherein a layer of paper 110 includes an inner surface 112 and an outer surface 114. Another layer of paper 116 includes an inner surface 118 and an outer surface 120. An adhesive material 126 is utilized to secure the inner surfaces 112, 118 together to form a laminated security paper. An authentication indicator 124 may be provided at a predetermined location on the inner surface 112 of the layer 110. The authentication indicator 124 may consist of magnetic material 122 to permit detectability and thus authenticate the security paper. The magnetic material 122 may be machine readable to enable the automatic detection, counting and authentication of the security

paper.

Figure 4 illustrates another embodiment of the present invention wherein a layer of paper 210 includes an inner surface 212 and an outer surface 214. Another layer 216 includes an inner surface 218 and an outer surface 220. Adhesive material 226 secures the layers 212 and 216 relative to each other. An authentication indicator 224 is provided for identifying the security paper. A Universal Product Code 222 may be provided as the authentication indicator 224 so as to permit automatic detection, counting and authentication of the security paper.

In addition, the security paper may be constructed to be a lamination which is opaque to visible light. The authentication indicia may be imperceptible to either reflected or transmitted light or radiation. The laminated security paper would be constructed to be translucent to non-visible light. The authentication indicator may be detectable by the non-visible light so as to be detectable in an appropriate optical instrument operating in the non-visible light wavelength.

The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

### Claims

1. A security paper comprising:
  - a first layer of paper having an inner surface and an outer surface;
  - a second layer of paper having an inner surface and an outer surface; and
  - an authentication indicator disposed on an inner surface of at least one of said layers of paper;
 the inner surfaces of said layers of paper being affixed relative to each other to form a lamination with said authentication indicator being disposed therebetween and said authentication indicator being substantially imperceptible in said security paper in reflected light.
2. A security paper according to claim 1 in which said authentication indicator is detectable in said security paper by submitting the paper to examination by radiation, other than in reflected light.
3. A security paper according to claim 2 in which said authentication indicator is detectable in said paper by at least one of the following means, namely in transmitted radiation in the visible spectrum, under non-visible irradiation and magnetically.

4. A security paper according to claim 1 or claim 2 or claim 3 wherein said authentication indicator is a detectable universal product code.
5. A security paper as claimed in any one of claims 1 to 4 further including adhesive affixing said inner surfaces of said layers of paper together.
6. A security paper according to claim 5 wherein the adhesive has greater resistance to chemical, thermal and mechanical degradation than said layers.
7. A security paper according to claim 5 or claim 6 wherein the adhesive is a thermosetting adhesive.
8. A security paper according to any one of claims 5 to 7 wherein the adhesive is selected from carboxylated polymers, thermosetting acrylics and N-methylol acrylamide interpolymers.
9. A security paper according to any one of claims 5 to 8 wherein the adhesive includes a pigment or dye.
10. A security paper according to any one of claims 1 to 9 wherein the light scattering, absorption reflectance and transmission characteristics of the layers, authentication indicator, and adhesive where present, are such that said indicator is detectable in said paper in transmitted light but substantially imperceptible in said paper in reflected light of visible wavelength.
11. A security paper according to any one of claims 1 to 9 wherein the color and optical characteristics of the layers, and adhesive where present, and the color, color intensity and optical characteristics of the authentication indicator are such that said indicator is detectable in said paper in transmitted light but substantially imperceptible in said paper in reflected light of visible wavelength.
12. A security paper as claimed in any one of claims 2 to 9 wherein said authentication indicator is fluorescent.
13. A security paper as claimed in claim 12 when said authentication indicator fluoresces in ultra violet light.
14. A security paper according to any one of claims 1 to 13 wherein at least one of said layers of paper includes a dye or pigment.
15. A security paper according to any one of claims 1 to 14 wherein said authentication indicator comprises indicia printed on an inner surface of at least one of said layers of paper.
16. A security paper according to claim 15 wherein said indicia are printed in ink.
17. A security paper according to any one of claims 1 to 16 wherein said authentication indicator comprises first authentication indicia printed in a first medium and second authentication indicia printed in a second medium, said indicia being printed on at least one of said layers of paper.
18. A security paper according to claim 17, wherein first authentication indicia are printed on the inner surface of one layer in a first medium; and second authentication indicia are printed on the inner surface of the other layer in a second medium.
19. A security paper according to claim 17 or claim 18 wherein said second medium is substantially the same as said first medium.
20. A security paper according to claim 17, 18 or 19 wherein said second authentication indicia comprise a watermark and the second medium is oil or a chemical treatment.
21. A security paper according to any one of claims 1 to 20 wherein said authentication indicator includes at least one of the following; namely, a half tone design; a stripe disposed in a predetermined spatial relation to at least one edge of said at least one layer; and optically readable characters.
22. A security paper is claimed in claim 5 comprising:
  - a lamination of a plurality of layers of paper, each said layer having predetermined mechanical, color and optical characteristics, said lamination including adhesive permanently adhering interior surfaces of said sheets together to form said lamination, said adhesive having predetermined color and optical characteristics and having greater resistance to chemical, thermal and mechanical degradation than said layers; and
  - authentication indicia printed in a chemically, thermally and mechanically stable medium on at least one interior surface of at least one of said layers, said medium having predetermined color and optical characteristics;
  - the color and optical characteristics of said layers, said adhesive and said medium combining to render said authentication indicia detectable in transmitted light but substantially imperceptible in reflected light of visible wavelength.



23. A method of manufacturing composite security paper as claimed in any one of claims 1 to 23 said method comprising the steps of:
- providing at least two layers of paper each having an inner surface and an outer surface; 5
  - printing said authentication indicator on said inner surface of at least one of said layers;
  - applying adhesive to at least one of said inner surfaces of said layers; and
  - adhesively joining the respective inner surfaces of said layers to form a lamination. 10
24. A method according to claim 23 wherein said printing step uses offset printing, flexographic printing, or rotogravure printing. 15
25. The method according to claim 23 or claim 24 wherein adhesive is applied flexographically or by rotogravure. 20
26. A document authentication system comprising:
- a document comprising a lamination of a plurality of layers of paper, each said layer having predetermined mechanical, color and optical characteristics, said lamination including adhesive permanently adhering inner surfaces of said layers together to form said lamination, said adhesive having predetermined color and optical characteristics and having greater resistance to chemical, thermal and mechanical degradation than said layers; and 25
  - authentication indicia printed in a chemically, thermally and mechanically stable medium on at least one interior surface of at least one sheet, said medium having predetermined color and optical characteristics; 30
  - the color and optical characteristics of said sheets, said adhesive and said medium combining to render said authentication indicia detectable in transmitted light of a predetermined wavelength and substantially imperceptible in reflected light of visible wavelength; 40
  - a source of light of said predetermined wavelength; and
  - means permitting selective placement of said document in position to transmit therethrough said light of predetermined wavelength. 45

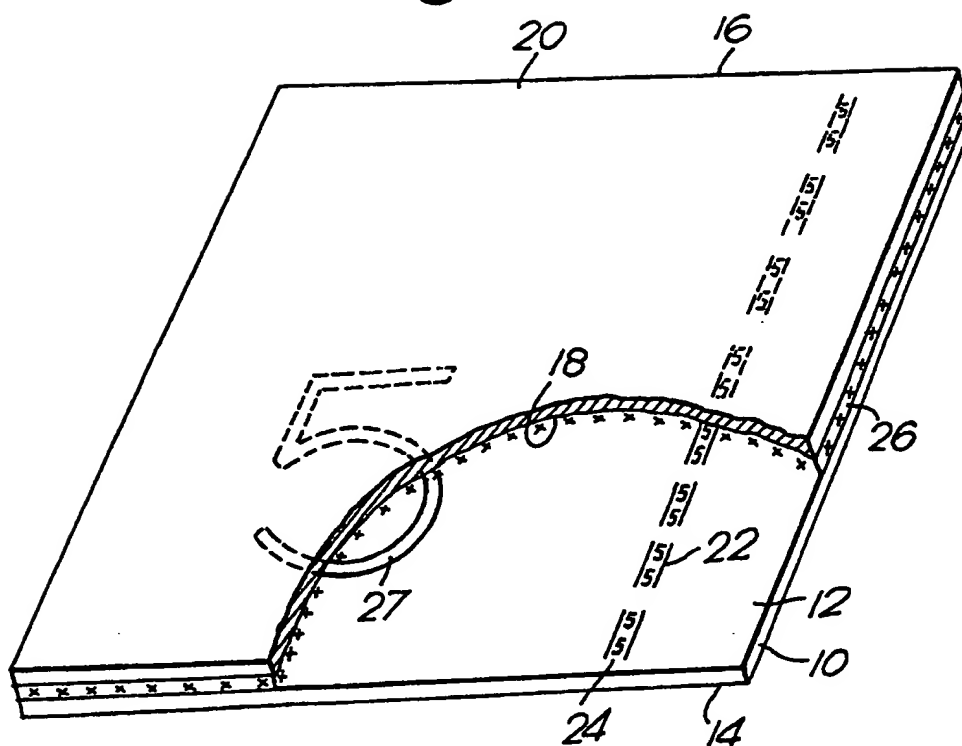
50

55

10



*Fig. 1.*



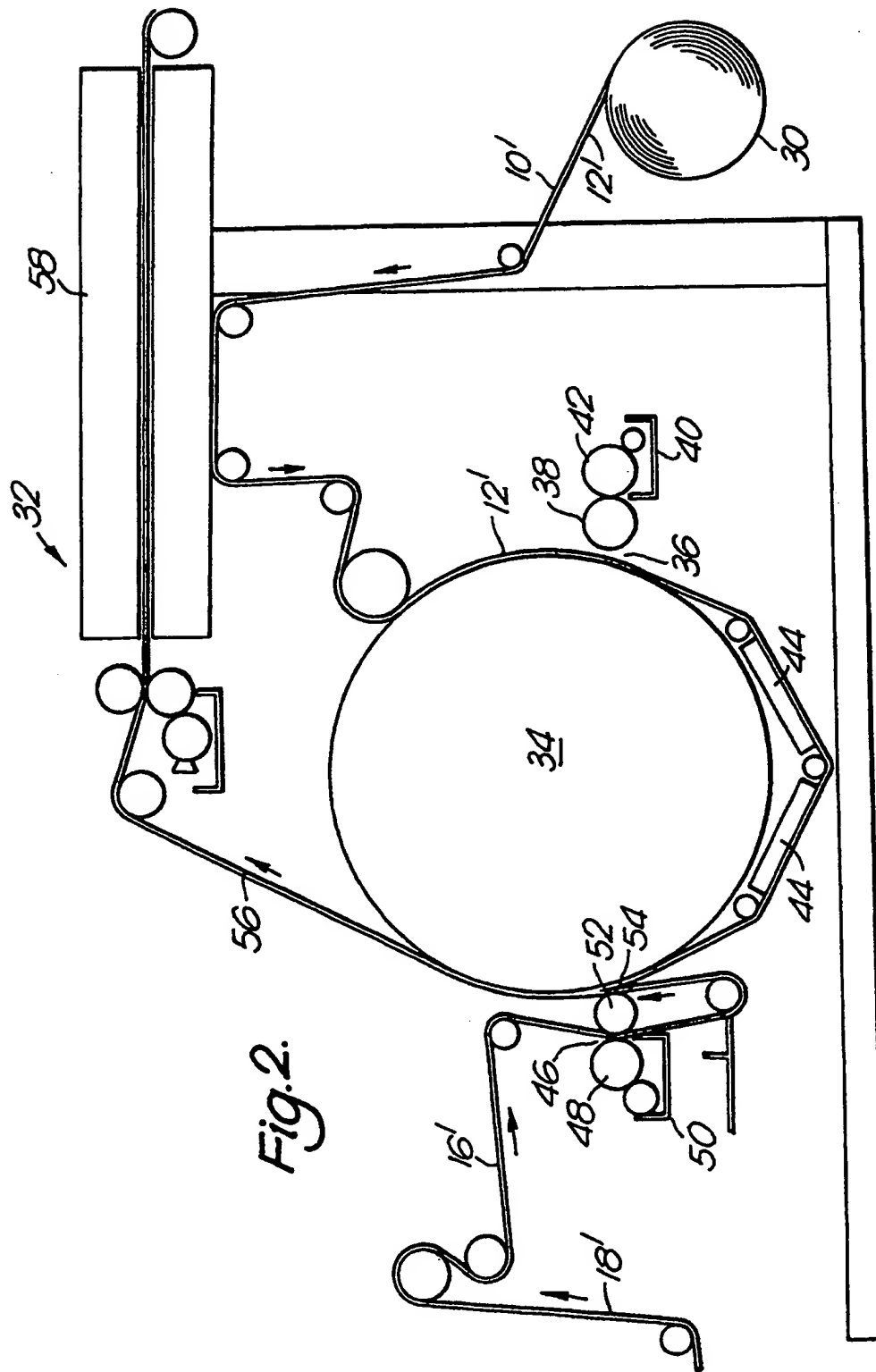


Fig. 2.

Fig.3.

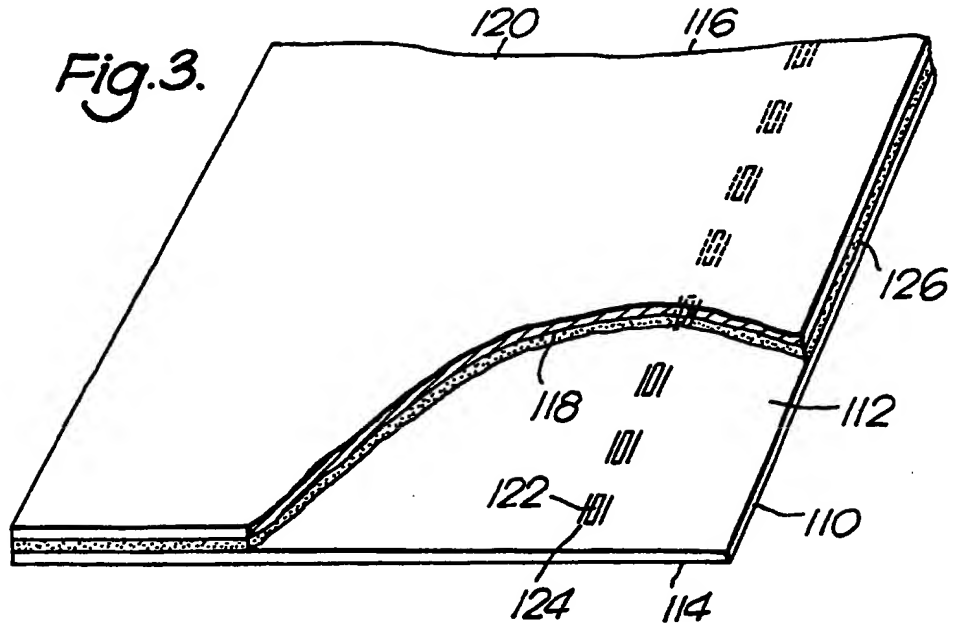
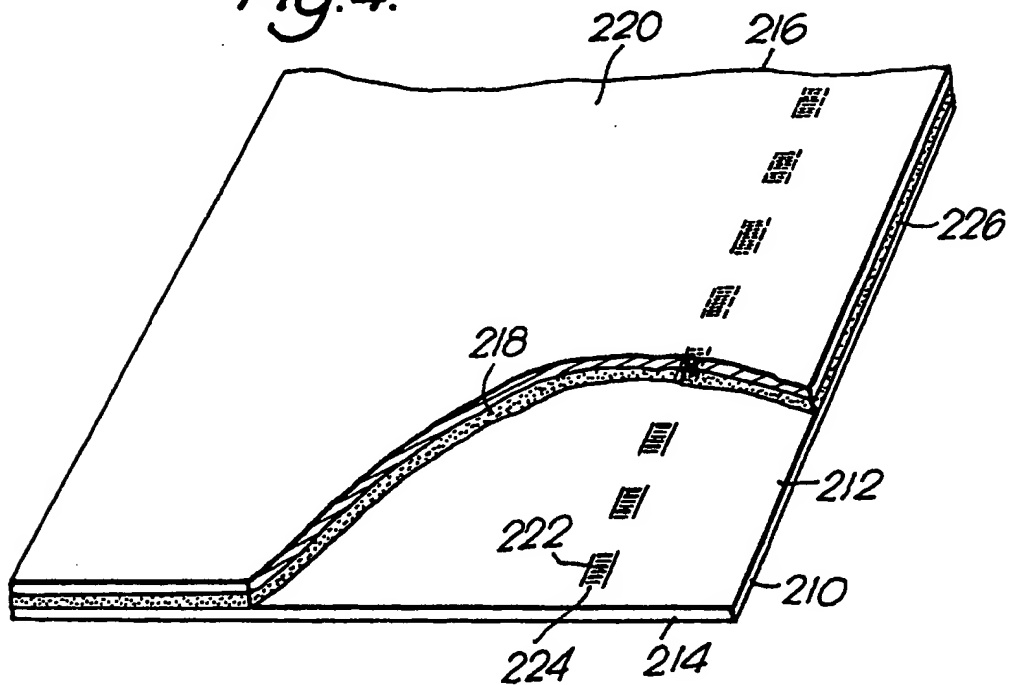


Fig.4.



(19)



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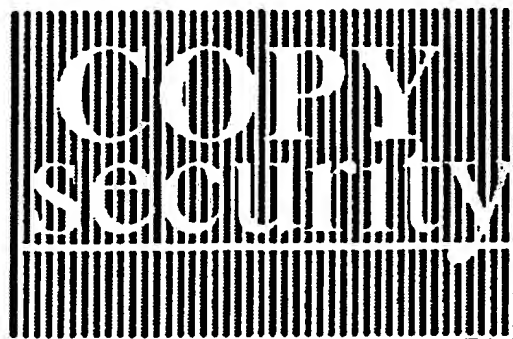
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(54) **Copy-protected documents and printing method for obtaining copy-protected documents**

(57) The invention relates to documents, in particular so called security documents including banknotes and the like, which are protected against copying, and to a method for printing such documents.

According to the invention at least part of the information

on the documents consists of lines and/or parts of lines and/or dots having a width of less than 20 micron and preferably the distance between those lines and/or parts of lines and/or dots is not less than 200 micron.



**FIG. 1**

**EP 0 721 849 A1**

## Description

The present invention relates to the protection of documents, in particular security documents, against counterfeiting by copying.

The expression "document" as used in this text refers to any support of visible information. Thus, a document according to this specification can consist of a sheet of paper or a sheet of any other material, or can even consist of any object, which sheet or object bears any information which is detectable with the eye.

The expression "information" as used in this text refers to any representation, image, text, message, symbol, pattern and the like, which may be applied in visible form on a document.

Counterfeiting of documents, in particular so called security documents, such as banknotes, shares, bonds, warrants, cheques, identity cards and other person identifying documents, visa, drivers licences, airplane tickets, bank cards, credit cards, post stamps, stickers for sealing and/or saving, food bonds, discount documents, diploma's, certificates, entrance documents, lottery tickets, securing stickers, and other secret or highly confidential documents, constitutes a severe problem. This problem has taken an increased importance with the development of colour photocopying equipment. In addition to the increasing quality of the colour reproductions, the number of colour copiers available on the market is steadily growing. The use of this equipment does not require special skills nor specialised technical knowledge in printing techniques and processes. The risk that such equipment is used for counterfeiting security documents, in particular for counterfeiting banknotes, is therefore constantly growing.

In order to protect security documents against counterfeiting, security printers use different printing processes such as wet or dry offset, intaglio, screen and typographical printing, using specific colours which are printed in rainbow and can not be obtained by a simple mixture of cyan, yellow, magenta and black; hybrid printing techniques are also used such as hot transfer for transferring foil, holograms, kinegrams, etc.

Furthermore, the paper of a security document such as a banknote is generally made of 100% cotton and is further protected by a watermark, a security thread, fluorescent fibers of different colours and length and/or by introducing different kinds of so called "planchettes" holding fluorescent, light-interference, or other eye or machine detectable characteristics.

Screened images and patterns generally used in the ordinary printing industry are generally avoided for this reason the design of e.g. a banknote is often completely based on images obtained by lines formed into security patterns and so called "guilloches".

Despite the mentioned security features, colour photocopying is to be considered a danger for the counterfeiting of banknotes, even when a number of the security features can not be reproduced or can only be reproduced with an unacceptably poor quality. Older

people, people with vision problems, less perceptive people or people under the stress of the circumstances are generally easy victims of colour photocopying counterfeited banknotes.

It has also been proposed to protect security documents by specific printing techniques involving that certain features of the information are modified upon copying. Examples of such copy-protection printing techniques are the so called Frequency Modulation (FREM) screening technique - as disclosed in EP 328 173 - and the so called Screen Angle Modulation (SAM) printing technique - as disclosed in EP 490 457.

These new developments, although providing interesting improvements with respect to the standard processes referred to above, however still have inherent drawbacks in respect of processability and/or effectiveness of their counterfeit protection.

The present invention now provides a new method for obtaining copy-protected documents which is based on a totally new concept.

Whereas known methods have sought to include provisions on the documents which are not reproducible by copying (watermark, metal security thread, fluorescence, etc.), or have sought that certain features of the information are modified upon copying (FREM technique, SAM technique), the method according to the invention involves that the information itself which is produced according to said method is not copied, i.e. the information itself disappears.

The invention is based on the finding that very fine lines, having a width in the order of 5 micron, can be produced with commercial wet-offset printing techniques, but that the currently known colour photocopiers are not able to reproduce fine lines having a width in the order of 20 micron or less. Thus, although the output resolution of a write-out laser is higher than a line thickness of 20 microns, it is not possible for colour copiers to reproduce such very fine lines even though the toners of the photocopiers have a particle size of 5 to 6 microns.

It has for instance been demonstrated that lines having a thickness of 14 microns, printed on a normal banknote paper using a common offset ink holding reflective pigments, with fluorescent characteristics under UV light infrared visible or invisible black ink and/or metallic inks, could easily be seen by the human eye but could not be detected by the colour photocopier and could not be reproduced by this type of machinery.

The invention accordingly provides a copy-protected document on which at least part of the information consists of lines and / or parts of lines and/or dots having a width of less than 20 micron.

It has furthermore been found that to obtain an optimal non-copy result, the distance between the printed fine lines in accordance with the invention should not be less than 100 micron preferably not less than 200 micron and most preferably not less than 250 micron to avoid that the colour copier integrates a number of lines as a broader line or surface covering colour shade.

Accordingly the invention preferably provides a copy-protected document on which at least part of the information consists of lines and / or parts of lines and/or dots having a width of less than 20 micron, whereas the distance between lines and / or dots is not less than 200 micron.

According to a preferred embodiment of the invention at least part of the information consists of a pattern of lines and / or dots having a width of less than 20 micron whereas the distance between lines and / or parts of lines and/or dots is not less than 200 micron.

The invention also provides a method for printing documents in which at least part of the information on the document is printed using lines and / or parts of lines and/or dots having a width of less than 20 micron whereas preferably the distance between lines and / or parts of lines and/or dots is not less than 200 micron.

According to a preferred embodiment of the printing method of the invention at least part of the information on the document is printed as a pattern of lines and / or dots having a width of less than 20 micron whereas the distance between lines and / or parts of lines and/or dots is not less than 200 micron.

The printing method of the invention is very suitably carried out using the wet offset printing technology. It has indeed been found that the proper plate making and print production with fine lines according to the invention can not or hardly be achieved with relief plates as used for dry offset technology. The reason for this seems to reside in the fact that the relief on top of the plates apparently limits the width of the fine lines to about 30 micron, due to the underwashing (photopolymer plates) or underetching (metal plates) phenomenon of the printing relief and due to breaking away of fine lines relief during the washing out, etching and/or printing process.

Wet-offset plates, generally known in the common printing industry as presensitized offset plates, do not have such relief, do not need to be washed out, neither to be etched in a way as described above for dry-offset plates. By moistening the plate before inking it maintains the ink acceptance of the printing parts and the refuse of ink of the non-printing parts.

Because of the absence of the relief, wet-offset plates permit to copy finer lines and to keep the fine lines on the plate during printing.

It is a further feature of the invention to integrate the concept of copy-protection of documents by means of fine lines with other copy-protection means.

Thus, according to a further embodiment of the invention, copy-protected documents are provided in which at least part of the information on the document consists of lines and / or parts of lines and/or dots having a width of less than 20 micron and being composed of colours of the so called PANTONE MATCHING SYSTEM (PMS) standard, which cannot be easily reproduced by a mixture of magenta, cyan, yellow and black.

Using such colours for printing the above mentioned very fine lines, respecting mutual distances between the lines leads to a pattern that can not be

reproduced by a colour photocopier.

In case the apparent density of the printing should be too high - f.e. resulting from the use of an excessive quantity of ink and/or pressure in the printing press so that the line width is extended and become larger than 20 microns on the printed paper - the colour reproduction will show an integration of lines into a full surface but still will produce a reproduction in a wrong colour shade.

The fine lines according to the invention may be oriented in any direction with respect to the length direction of the support, such as vertical, horizontal or any other direction, or in combinations of directions, either as isolated fine lines, or integrated and / or built into line structures and / or patterns and / or so called guilloches.

It is also of no importance whether the fine lines are printed in single colour or multi colour.

According to another interesting feature of the invention, information may be embedded in the fine line patterns protecting the documents. It has been found that this feature increases the perception by the human eye. Information can be embedded in different ways and/or combinations such as styling the length of the lines in such a way that they form a perceptible image; using varying line thicknesses in a modulated way so that the differences in thickness of the very fine lines form an image to the human eye whereby it has been taken care that no point of the line has a thickness above 20 microns; reserve the image in an equal tone very fine line pattern; printing an image using two printing plates whereby the second print makes an inprint and creates an image between the fine lines resulting from the first printing plate, etc.

Because of paper distortion due to the moisture of the plate and for reasons of print register, embedded information by inprinting a second colour should preferably be printed in a one-operation printing machine using a printing press preferably based on the satellite-construction principle such as a 4/4 Super-Simultan press, which is a wet-offset press specially used for printing banknotes and high security documents.

Thus, the fine line patterns according to the invention may for instance consist of patterns of parallel fine lines printed in alternating colours A and B, with line widths of below 20 micron, preferably from 5 to 20 micron, most preferably in the order of 10 to 14 micron, and with distances between the lines of at least 100 micron, preferably at least 200 micron, most preferably in the order of 250 micron, whereas the lines A are printed by a first printing plate and the lines B are printed by a second printing plate.

The fine line patterns according to the invention may for instance also consist of information patterns embedded in the patterns of fine lines, as illustrated in figure 1.

The patterns of fine lines may on the other hand also form the patterns of information, as illustrated by figure 2.

The copy-protection print according to the invention may furthermore also consist, for instance, of single col-

our printed patterns as illustrated in figure 3, combining horizontal and vertical fine lines. The information pattern "BNB" is embedded by using different line directions and different line widths inside the embedded pattern. Square dots are obtained by considering these dots as fine lines having a length equal to their width. Such dots are distinct from those resulting from a photographic or computer controlled screening technique and are not to be confused with those resulting from said letter techniques.

The copy-protection print according to the invention may on the other hand also consist, for instance, of single colour printed patterns as illustrated in figure 4. This embodiment of the invention is similar to that illustrated in figure 3, except that in addition in the information pattern "BNB" a guilloche pattern has been printed in offset underneath the fine line structure. The line patterns are printed on top and in register with the offset printing underneath.

It should be noted in respect of the figures that although in the practice of the invention lines are used with line widths of below 20 micron, preferably from 5 to 20 micron, most preferably in the order of 10 to 14 micron, and with distances between the lines of at least 100 micron, preferably at least 200 micron, most preferably in the order of 250 micron, for the sake of illustration the relative proportions of the line widths and line distances with respect to each other and with respect to the embedded information patterns or with respect to the information patterns formed by the lines, have NOT been observed.

Documents according to the invention may be printed on paper, either with or without watermark, or on totally or partly synthetic materials and substrates such as polyethylene, polyester, polypropylene, polycarbonate, or other plastic substrates, whether these substrates are transparant, translucent metallic substrates or any other substrate obtained by combining several of said substrates or opaque.

Documents according to the invention may also be coated, be it over part of, or the entire image, or over the total surface of the document. It is unimportant whether this coating is a varnish, a UV curing laquer, a gelatine layer or any other coating or layer having image receiving characteristics or not, or whether the documents are printed on substrates preprinted in offset or in another printing process like silkscreen, flexographic printing, typographical printing, gravure printing, intaglio printing, inkjet printing, hot transfer and/or cold transfer, wax printing or other printing systems, whereby one or several pigments have been used such as common reflective pigments, metal pigments, photochromatic pigments, light sensitive pigments, fluorescent pigments, phosphorescent pigments, magnetic pigments, pigments visible or invisible under infrared illumination or light interference pigments have been printed underneath or on top of the fine lines (of less than 20 microns line width), or whereby one or several of said pigments are used as pigment in the ink to print said fine lines.

According to the invention it is also possible to proceed in such manner that the fine lines are not printed directly onto the document but preprinted on a temporary substrate in order to be brought onto the final substrate by using a transfer technique, whether this transfer technique is a hot or a cold transfer technique.

On the other hand the fine lines may also be printed or transferred onto a transparant substrate in order to put this substrate as a protective layer over a preprinted document in order to protect this receiving document against unauthorised acces or fraude, by using laminating processes, glue or another adhesion technique, without importance if the document itself shows fine lines of less than 20 microns line width.

The fine lines may also be printed or transferred on a receiving document which is not preprinted but carrying an image or information brought onto the document by applying other techniques and processes than printing such as photography, DTR transfer, embossing, encoding by punching or other mechanical treatment, sputtering or any other technique permitting to bring information onto a substrate.

In accordance with the invention it is also possible to provide the fine lines not directly onto the surface of the document or substrate, but be put on the document or substrate as a sticker, an overlay sheet or other protecting securising item.

According to the invention the substrate may also be provided with a preprinted pattern of fine lines, constituting security information, which substrate can be used afterwards for receiving confidential or secret information using photocopy machines, digital printing presses and systems regardless the technology used by the printing press or system, data transmitting systems, computer printers, designing and landmap plotters and all other data writing and/or designing systems whether the system has been developped and/or used for civilian or military purposes. This is particularly usefull when it is an absolute necessity that the data and/or data sheets are reproduced and distributed in a controlled number of copies and/or when the recipients of such copies need a feature for checking authorized and approved copies out of fraudulent unauthorized ones.

Additional features of the invention will result from the following description of detailed embodiments provided by way of illustration, without limiting the scope of the invention.

Other embodiments of the invention and modifications with respect to the given embodiments will be readily understood by those skilled in the art and are considered to be within the scope of the invention.

#### EXAMPLE 1

A film with very fine lines having 14 microns thickness was obtained by using an Adobe Illustrator 3.2 software, a Macintosh computer working in Postscript language, with a Scangraphic Imagesetter Scantext 2030 PS as plotter, used on its highest resolution of

3.252 DPI. For plotting the fine lines of 14 microns "Accumax Rapidaccess" film made by Kodak has been used. As contactfilm for copying the printing plate "Contact 2000 CA7" film made by Kodak was used.

The copy of 14 micron thick lines could be obtained on different wet-offset plates available on the market such as aluminium Polychrome GP 6 plates, Trimetalic plates and other commercial wet-offset plates. For determining the optimal exposure and development time of the plates, an UGRA controlestrip was added in order to control the different steps of platemaking. On the copy frame for plate copy the electrical power was stabilised, the vacuum system put to a maximum for having a maximum contact between the film and photosensible layer of the printing plate and the lamps controlled on light intensity, light distribution and stability.

Using this method and controlling very strictly every step of the platemaking, a wet-offset plate with only 14 microns thick lines was obtained.

#### EXAMPLE 2

A similar fine line pattern has also been plotted on a Barco 9700 plotter using a resolution of 10.160 DPI. This resulted in very fine curved guilloche lines of a very high quality. Vertical and horizontal lines on this apparatus resulted in very high quality lines of 10 to 11 microns. Curved lines plotted on this apparatus maintained a very high quality and did not show a broken effect up to a thickness of 14 to 15 microns being completely below the reproduction possibilities of the colour photocopiers.

#### EXAMPLE 3

Printing of the plates of examples 1 and 2 has been done on a GTO Heidelberg offsetpress which is a commercial known machine and on a Super-simultan 4/4 wet-offset press which is a printing press used for printing the offset printed images on banknotes and other security documents. Both these machines are equipped with a water/alcohol moistening system for wet-offset printing. All these machines were brought into optimal technical conditions, blankets, cylinders and inking rollers were controlled up to tolerances of 1/100 of a mm, print pressure during printing was kept severely under control and the print process was undertaken under thermostabilized working conditions.

#### EXAMPLE 4

The prints obtained in example 3 have been photocopied using standard commercial colour copiers. In particular use was made of a CANON CLC 500 colourcopy machine. On the obtained copies, the fine line pattern areas of the printed documents appeared as blank areas.

#### Claims

1. Copy-protected document, characterised in that at least part of the information on the document consists of lines and / or parts of lines and/or dots having a width of less than 20 micron.
2. Copy-protected document according to claim 1, characterised in that the distance between lines and / or parts of lines and/or dots is not less than 200 micron.
3. Copy-protected document according to claim 1, characterised in that at least part of the information consists of a pattern of lines and / or parts of lines and/or dots having a width of less than 20 micron whereas the distance between lines and / or dots is not less than 200 micron.
4. Copy-protected document according to claim 1, characterised in that at least part of the fine lines are composed using colours of the PMS standard.
5. Method for printing documents, characterised in that at least part of the information on the document is printed using lines and / or parts of lines and/or dots having a width of less than 20 micron.
6. Printing method according to claim 5, characterised in that the distance between lines and/or parts of lines and/or dots is not less than 200 micron.
7. Printing method according to claim 5, characterised in that at least part of the information on the document is printed according to a pattern of lines and / or parts of lines and/or dots having a width of less than 20 micron whereas the distance between lines and / or parts of lines and/or dots is not less than 200 micron.
8. Printing method according to claim 5, characterised in that at least part of the fine lines are composed using colours of the PMS standard.
9. Copy protected document, respectively printing method according to any one of the preceding claims, characterised in that information is embedded in the fine line patterns protecting the documents.
10. Copy protected document, respectively printing method according to claim 9, characterised in that the fine line patterns consist of information patterns embedded in the patterns of fine lines (as illustrated by figure 1), form the patterns of information (as illustrated by figure 2), consist of printed patterns combining horizontal and vertical fine lines with an information pattern embedded by using different line directions and different line widths inside the



embedded pattern (as illustrated by figure 3), optionally comprising a guilloche pattern printed in offset underneath the fine line structure (as illustrated by figure 4).

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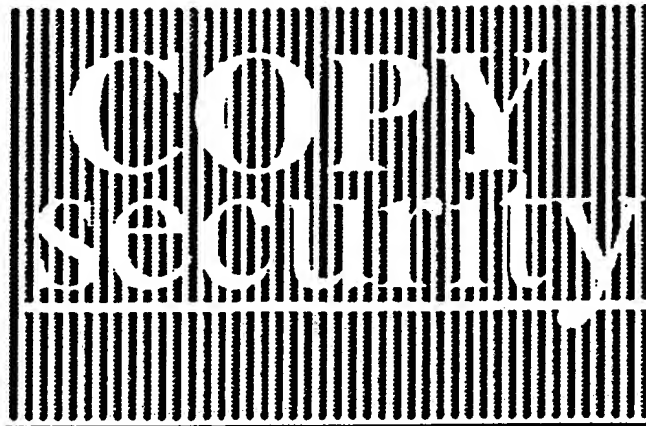


FIG. 1

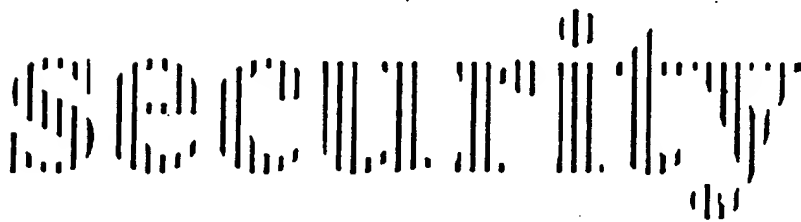


FIG. 2

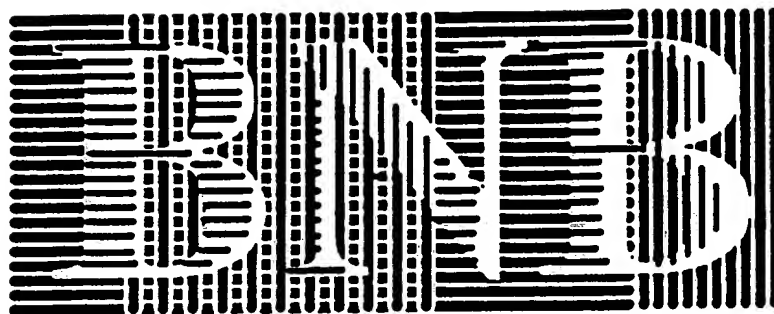


FIG. 3

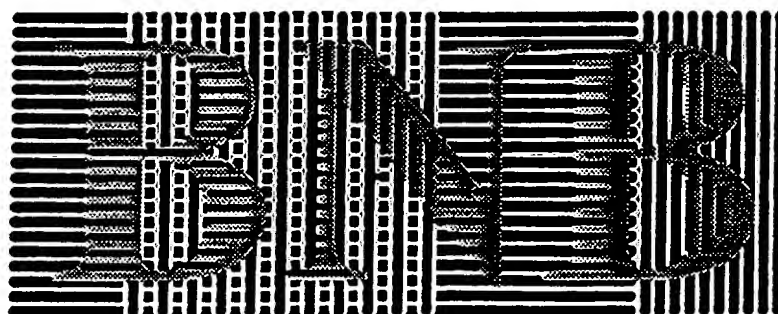


FIG. 4



European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number  
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DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	EP-A-0 546 765 (MOORE BUSINESS FORMS) * column 3, line 29 - line 41 * ---	1-10	B42D15/00 B41M3/14
X	EP-A-0 384 897 (DE LA RUE GIORI) * claim 8 * ---	1-10	
A	GB-A-2 217 258 (SUOMEM PANKIN SETELIPAINO) * the whole document * -----	1,5	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B42D B41M
The present search report has been drawn up for all claims			
Place of search <b>THE HAGUE</b>		Date of completion of the search <b>28 June 1995</b>	Examiner <b>Evans, A</b>
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**Data carrier**

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Publication  
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Cited  
Documents: DE3225485; US5549953; EP0219012; DE2943436; US4578298; US5248544; US4892385

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**Abstract**

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The data carrier stores data that is protected against misuse or copying. The carrier is produced with two special layers Ä1,2Ü that contain watermarks or other security patterns. The layers are of various materials and are bonded in a number of ways e.g. with adhesive or by hot bonding. They are of a reactive form using ultraviolet, infra red or an electron beam. The layers are covered in protective material Ä3,4Ü.

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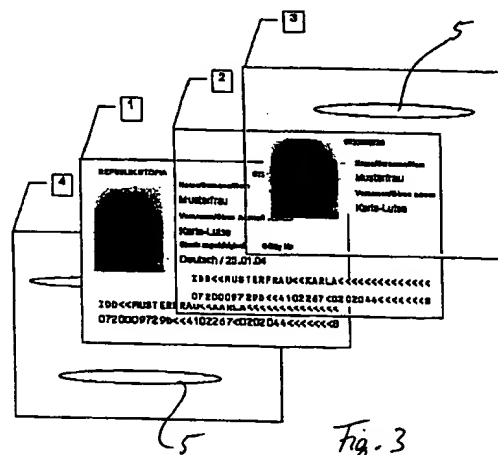
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(54) Datenträger

(57) Die Erfindung bezieht sich auf einen Datenträger, z.B. personalisiertes Wertpapier wie Personalausweis, Scheckkarte u.dgl., mit Bild- und/ oder Textdaten in codierter und/ oder uncodierter Form. Um Fälschungen bzw. Verfälschungen der Daten extrem zu erschweren bzw. zu verhindern sind die Bild- und/ oder Textdaten des ersten Datenträgers (1) mindestens teilweise als separate optisch variable Elemente zusätzlich auf dem zweiten, transparent und/ oder teiltransparent ausgebildeten Datenträger (2) wiedergegeben.



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## Beschreibung

Die Erfindung bezieht sich auf einen Datenträger, z.B. personalisiertes Wertpapier wie Personalausweis, Scheckkarte u.dgl., mit Bild- und/oder Textdaten in codierter und/oder uncodierter Form.

Ein Datenträger in Form eines personalisierten Wertpapiers ist z.B. eine Scheckkarte, die mehrschichtig aus einem Inlett aus Papier/Pappe oder Kunststoff und zwei transparenten Deckfolien gebildet ist. Auf dem Inlett befinden sich Bild- und/oder Textdaten in codierter und/oder uncodierter Form, wie Bank- und Kontobezeichnungen sowie der Name und/oder das Foto des Inhabers der Scheckkarte. Durch den mehrschichtigen Aufbau werden Fälschungen bzw. Verfälschungen der Scheckkarte zwar erschwert, jedoch nicht vollständig verhindert.

Der Erfindung liegt die Aufgabe zugrunde, einen Datenträger der gattungsgemäßen Art zu schaffen, bei dem Fälschungen bzw. Verfälschungen der Daten extrem erschwert bzw. sogar verhindert werden.

Zur Lösung dieser Aufgabe sieht die Erfindung vor, daß die Bild- und/oder Textdaten des einen Datenträgers mindestens teilweise als separate optisch variable Elemente zusätzlich auf dem anderen, transparent und/oder teiltransparent ausgebildeten Datenträger wiedergegeben sind. Der erfindungsgemäße Datenträger besteht somit aus der Kombination zweier analoger Datenträger, von denen der eine die Bild- und/oder Textdaten in codierter und/oder uncodierter Form und der andere die Bild- und/oder Textdaten mindestens teilweise als separate optische variable Elemente aufweist. Beide analogen Datenträger sind zu einem Datenträger vereinigt, wobei z.B. ein Schichtenaufbau aus dem die Bild- und/oder Textdaten in codierter und/oder uncodierter Form aufweisenden Datenträger und dem die Bild- und/oder Textdaten mindestens teilweise als separate optisch variable Elemente aufnehmenden zusätzlichen Datenträger gebildet ist. Der Datenträger, der die holografischen Informationen enthält, ist transparent und/oder teiltransparent ausgeführt. Die auf dem Datenträger enthaltenen Daten bzw. Informationen sind ganz oder teilweise als separate optisch variable Elemente in Form von Beugungsgittern, Hologrammen und/oder Kinegrammen zusätzlich auf dem transparenten und/oder teiltransparenten Datenträger wiedergegeben.

Der Grundgedanke der Erfindung besteht darin, die variablen und/oder nicht variablen Daten des Datenträgers bzw. Dokuments durch mindestens zwei unterschiedliche Verfahren wiederzugeben. Die beiden Datenträger sind dabei so miteinander kombiniert, daß ein neuer Datenträger gebildet wird. Hierbei ist die dublierte Information die direkte Verknüpfung beider Wiedergebeverfahren, wobei auf dem zusätzlichen transparenten und/oder teiltransparenten Datenträger die physikalischen Eigenschaften von Beugungsgittern genutzt werden, um die Daten bzw. Informationen wie-

derzugeben.

Die aufzunehmenden bzw. zu übertragenden Daten bzw. Informationen wechseln von Datenträger zu Datenträger bzw. Dokument zu Dokument ihren Inhalt. Es entsteht so in einer Auflage der Höhe  $n$  eine entsprechende Anzahl  $n$  an Datenträgern bzw. Dokumenten, die neben einer Druckausgabe bzw. einer fotografischen Übertragung bestimmte Daten bzw. Informationen doppelt enthalten, d.h. in dem erfindungsgemäßen Fall als separate, optisch variable Elemente in Form von Beugungsgittern, Hologrammen und/oder Kinegrammen. Dabei können die optisch variablen Elemente zusätzlich durch ein maschinell detektierbares Merkmal gesichert sein.

Die zu verarbeitenden Daten bzw. Informationen werden manuell und/oder maschinell erfaßt, vollständig direkt ausgegeben oder teilweise direkt ausgegeben und teilweise gespeichert und dann ausgegeben bzw. komplett gespeichert und anschließend ausgegeben. Die Datenausgabe erfolgt mit mindestens zwei unterschiedlichen Ausgabeverfahren und entsprechenden Datenträgern, die in separaten Arbeitsgängen zu dem jeweiligen Endprodukt weiterverarbeitet werden.

Durch die Verwendung der erfindungsgemäßen Kombination von Datenträgern können z.B. Sicherheitsprodukte derart mit Absicherungstechnik versehen werden, daß durch das Summieren wiedergabeverfahrenspezifischer Sicherungstechniken Fälschungen bzw. Verfälschungen extrem erschwert bzw. verhindert werden.

Die Erfindung ist nachfolgend anhand eines in den Zeichnungen dargestellten Datenträgers in Form eines mehrschichtigen Personalausweises näher erläutert. Es zeigen:

Fig. 1 einen prinzipiellen Querschnitt durch den Datenträger,

Fig. 2 die vier Schichten des Datenträgers als Einzelbilder und

Fig. 3 die vier Schichten des Datenträgers in Explosionsdarstellung.

Der Datenträger 1 ist ein Bedruckstoff bzw. Trägermaterial und besteht z.B. aus Papier/Pappe, Kunststoff, Metall oder einer Kombination von Papier/Pappe, Kunststoff und Metall sowie einem solchen kombinierten Material mit Akzeptorschicht, z.B. fotografische Emulsionen, spezielle Beschichtungen für Druck-, Tintenstrahl-, Thermosublimations-, Thermotransfer-, Xerographie- usw. -verfahren.

Der aufkaschierte Datenträger 2 ist ein holografischer transparenter und/oder teiltransparenter Träger, z.B. aus Photopolymermaterial, zur Verarbeitung im optisch/digitalen Verfahren, oder eine Folie zur Aufnahme von geprägten holografischen Strukturen zur Bearbeitung mittels mechanischer Verfahren. Die Bild-

und/oder Textdaten des Datenträgers 2 sind räumlich versetzt zu den Bild- und/oder Textdaten des Datenträgers 1 angeordnet, wie es aus Figuren 2 und 3 ersichtlich ist.

Die Datenträger 1 und 2 sind in speziellen Verfahren miteinander verbunden, wobei die Datenträger 1 und 2 direkt oder mit Primerschichten wie z.B. Heißsiegel-, Selbstklebe-, Mehrkomponentenkleber und durch reaktive Systeme, wie z.B. UV, IR, Elektronenstrahl usw., verbunden werden.

Die verbundenen Datenträger 1 und 2 können zusätzlich einseitig und/oder zweiseitig mit einer transparenten Schutzschicht 3 und/oder 4 versehen sein, wobei die Schutzschicht 3, 4 aus unterschiedlichen Materialien bestehen kann, wie z.B. ein- oder mehrschichtigen Kunststoff mit Primerschichten, wie z.B. Heißsiegel-, Selbstklebe-, Mehrkomponentenkleber und reaktiven Systemen, wie UV, IR, Elektronenstrahl usw., oder ein-/mehrschichtigen Lacken in Form von Mehrkomponenten- oder reaktiven Systemen, wie UV, IR, Elektronenstrahl usw.

Der Datenträger 1 enthält übliche Sicherheitsmerkmale 5, wie z.B. Wasserzeichen, Melierfasern u.dgl.. Auch die Schutzschichten 3 und 4 können zusätzliche Sicherheitsmerkmale 5 beinhalten.

bares Merkmal gesichert sind.

6. Datenträger nach Anspruch 3, dadurch gekennzeichnet, daß das im optisch/digitalen Verfahren erzeugte Hologramm transparent und/oder teiltransparent aus Photopolymermaterial gebildet ist.
7. Datenträger nach Anspruch 3, gekennzeichnet durch eine Folie zur Aufnahme von geprägten holografischen Strukturen zur Aufbringung des Hologramms im mechanischen Verfahren.

#### Patentansprüche

1. Datenträger, z.B. personalisiertes Wertpapier wie Personalausweis, Scheckkarte u.dgl., mit Bild- und/oder Textdaten in codierter und/oder uncodierter Form, dadurch gekennzeichnet, daß die Bild- und/oder Textdaten des ersten Datenträgers (1) mindestens teilweise als separate optisch variable Elemente zusätzlich auf dem zweiten, transparent und/oder teiltransparent ausgebildeten Datenträger (2) wiedergegeben sind.
2. Datenträger nach Anspruch 1, dadurch gekennzeichnet, daß die optisch variablen Elemente in Form von Beugungsgittern auf dem zweiten Datenträger (2) angeordnet sind.
3. Datenträger nach Anspruch 1, dadurch gekennzeichnet, daß die optisch variablen Elemente in Form von Holo- und/oder Kinegrammen auf dem zweiten Datenträger (2) angeordnet sind.
4. Datenträger nach Anspruch 1, dadurch gekennzeichnet, daß die optisch variablen Elemente auf dem zweiten Datenträger (2) räumlich versetzt zu den Bild- oder Textdaten auf dem ersten Datenträger (1) angeordnet sind.
5. Datenträger nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß die optisch variablen Elemente zusätzlich durch ein maschinell detektier-



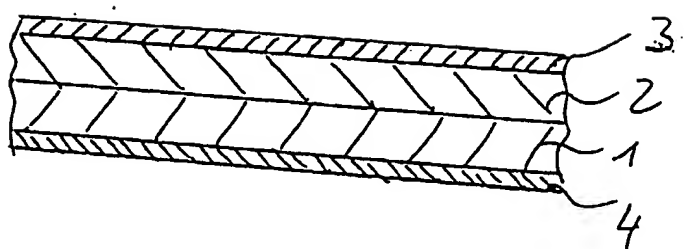
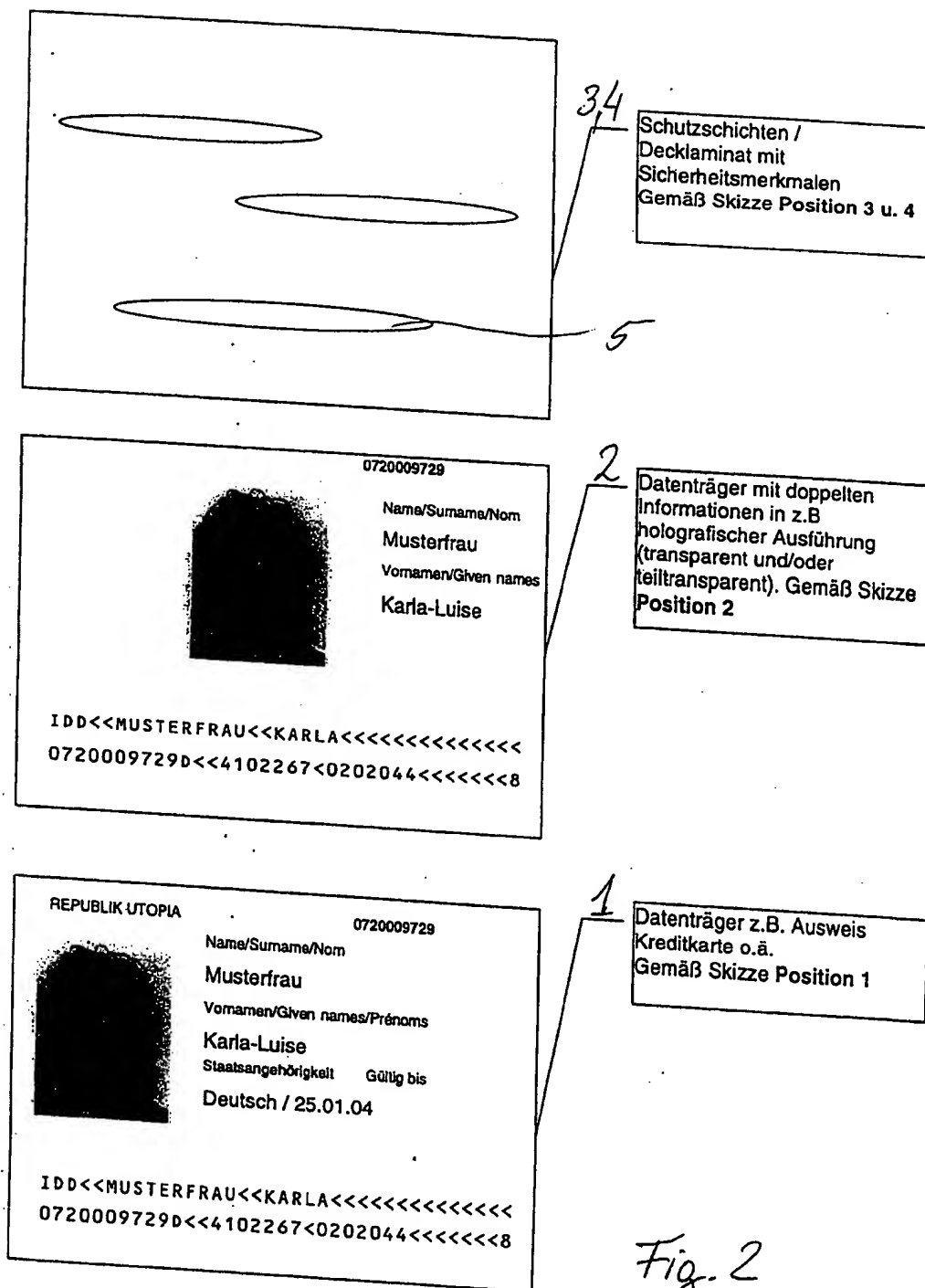


Fig. 1



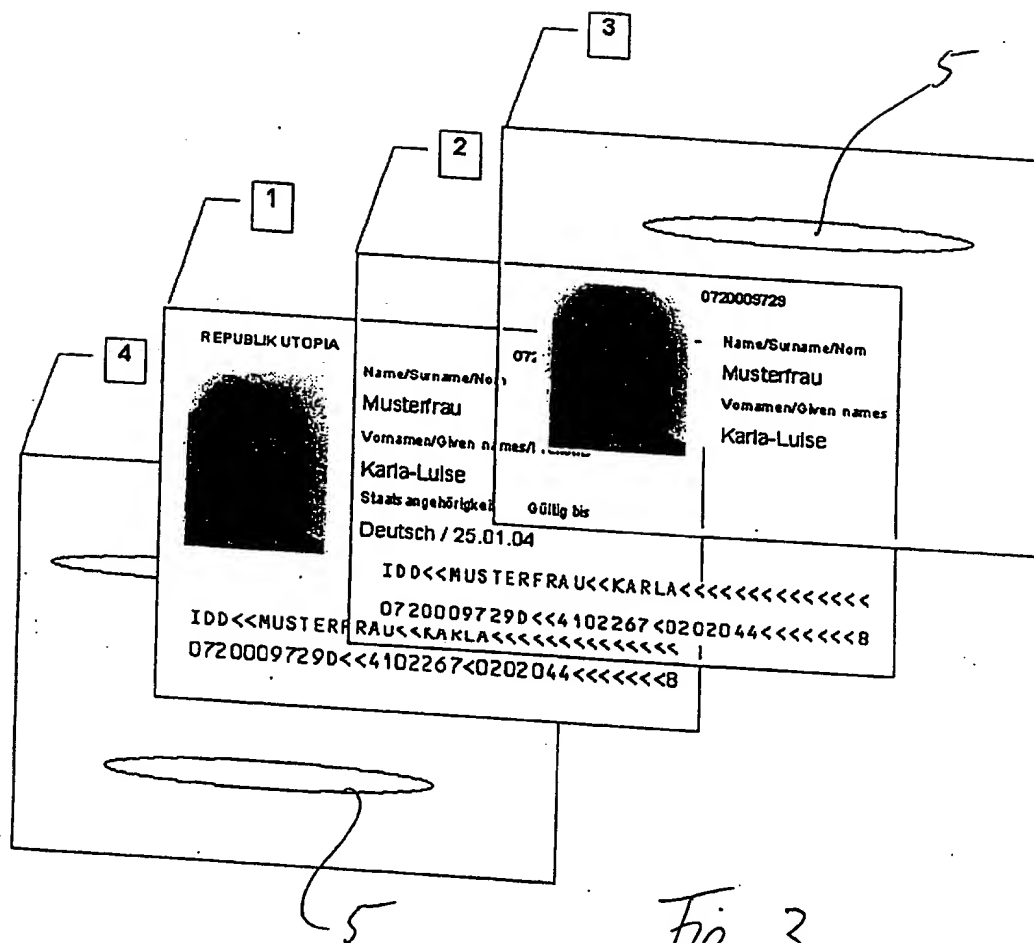


Fig. 3

(19)



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(54) **Lottery ticket paper, a method of manufacturing lottery ticket paper and the use of said paper in the manufacture of lottery tickets.**

(57) The invention relates to a new lottery ticket paper for the manufacture of different kinds of lottery tickets, especially of the "instant lottery ticket" type, and a method of manufacturing said tickets. The lottery ticket paper is characterized in that it comprises a coloured, opaque base paper coated on both sides with a composition comprising at least one pigment, a filler, a binder solution, and optionally viscosity regulating agents and some kind of security element. The lottery ticket paper is protected against see-through and various kinds of forgery. It is an environmentally pleasing, nonexpensive and from the production-technical point of view suitable alternative to existing foil-laminated lottery ticket papers.

**EP 0 428 489 A1**

The present invention relates to a new lottery ticket paper to be used in the manufacturing of lottery tickets, a method of manufacturing said lottery ticket paper, and to lottery tickets and a method of manufacturing said lottery tickets. The invention is especially concerned with a lottery ticket paper intended for lottery tickets such as, for example, so called instant lottery tickets.

Lottery tickets represent a special kind of security print which for reasons of security must be protected against see-through and various kinds of forgery.

The lottery tickets hitherto used and sold on the market are protected against see-through by being made from a foil-laminated paper material, usually an aluminium foil laminated to a stiff sheet of paper. The aluminium foil is printed with special printing inks which are volatile and/or require strong solvents. Said inks represent a potential hazard with respect to work environment as well as from a general environmental point of view. Also, the aluminium foil itself is extremely unsuitable from the environmental point of view, both in the manufacture of the foil-laminated sheet of paper itself and in taking care of the waste that is unavoidable in connection with printing and finishing of the product, as well as in destruction of the product after use.

Further, as a result of its sensitivity, the aluminium foil poses production-technical problems in the manufacture of aluminium foil laminated lottery tickets. Heavy demands are made as to printing accuracy, since if the foil is bent, folded or "cracked" during printing, the deformation will remain and the products have to be discarded.

From the forgery point of view, a multilayer product is unsuitable, since it may be delaminated and tampered with, for example by transferring information from one lottery ticket to another. Further, aluminium foil and sheets of paper are available on the market and can be used by forgers with knowledge of printing technique.

In the manufacture of lottery tickets it is of the utmost importance that it should be possible to check the number of lottery tickets made in a simple way. With existing equipment, aluminium foil laminated lottery tickets cannot be machine counted.

It is already known to use different types of coated paper for different applications mostly intended for the manufacture of paper with a bright and uniform quality. These coatings are usually very thin and, further, no suggestions have been made for the manufacture of instant lottery tickets by using a see-through protected base paper coated on both sides.

According to the present invention there is provided a new lottery ticket paper which is pro-

tected against see-through and which solves the above-mentioned problems connected with lottery ticket paper made from a foil-laminated paper material. The new tickets are protected against see-through, non-delaminatable, difficult to forge, and have a low grammage which gives low mailing expenses and facilitates storage of finished products. Further, the new tickets are nonexpensive to produce, congenial to the environment and suitable for printing, i.e. may be printed with conventional printing inks and conventional equipment, and may be machine counted using existing equipment.

Another object of the present invention is to suggest a method of manufacturing the new lottery ticket paper.

Yet another object of the invention is the manufacture of lottery tickets, especially so called instant lottery tickets.

The lottery ticket paper according to the invention is characterized in that it comprises a coloured, opaque base paper which is coated on both sides with a composition comprising at least one pigment, a filler, a binder solution, and optionally viscosity regulating agents. As an extra security feature, the coated paper may comprise some kind of security element, such as security chemicals, visible or non-visible fibres or a combination thereof.

The lottery ticket paper according to the invention is defined in claim 1 and in subclaims 2-5.

The base paper comprises a coloured, preferably black, cellulose containing paper or rag paper. By 'rag paper' is meant a paper containing textile. The base paper has a grammage of about 100 g/m<sup>2</sup> - 300 g/m<sup>2</sup> and is inked with a coloured pigment, the origin of which may be either synthetic or organic, which makes the paper opaque. To attain an opaque paper, the base paper should be inked with a pigment, which both absorbs most of the incident light rays and especially is light-scattering. According to the invention, by opaque is meant totally opaque, i.e. it is impossible to see through the base paper even under intensive light. For example, the opacity of the base paper is non-measurable by conventional opacity measurement methods for paper, such as SCAN-P8. The base paper is preferably inked with a black pigment, such as carbon black.

The coloured paper is coated on both sides with a bright coating composition, which makes the surface of the paper suitable for printing, meaning that the paper may be printed using conventional printing techniques, such as ordinary offset printing and/or screen printing. The coating according to the invention is thin, however, compared to conventional coated paper represents a relatively thick coating.

The base paper is preferably coated with the

coating composition to a grammage of the coating of between 10 g dry solid matter/m<sup>2</sup> of coated side and 30 g dry solid matter/m<sup>2</sup> of coated side, preferably 20 g - 30 g and especially 20 g - 25 g solid matter/m<sup>2</sup> of coated paper side. Pigments which may be used in the coating composition are preferably bright, non-fluorescent pigments, especially titanium dioxide or similar white pigments. Since the coating composition is preferably non-fluorescent, it is possible, when required, to use UV-fluorescent inks for the subsequent printing of the paper. By means of UV-fluorescent printing inks, it is easy to check the genuineness of the lottery tickets.

The filler is usually clay, kaolin, or other conventional filler used in the coating of paper. The binder may be, for example, latex, starch, or casein in a water-based solution. Alternatively, the binder solution may be a hot melt plastic.

For reasons of security, the lottery ticket paper may also comprise fibres which are visible or non-visible in daylight, or a combination thereof. Preferably, the fibres are UV-fluorescent fibres. The fibres may be included in the coating composition or laminated between the base paper and the coating. Fibres suitable for use in the lottery ticket paper according to the invention are fibres of synthetic or regenerated origin, e.g. polyamide, polyester or rayon fibres. Suitable fibres have a length of about 2 - 10 mm and preferably about 4 - 5 mm and a diameter of about 3 - 10 Dtex. A suitable amount of fibres in the coating is about 50 - 250 fibres/dm<sup>2</sup>.

Further, the coating composition may contain a further security element such as one or more so called security chemicals, which make the coating unique and protect the lottery ticket paper as well as the products produced against possible forgery such as by erasure or alteration of the printed paper. Security chemicals to be mentioned are, for example, Securistain, Clorostain, Solvent Black and Nitrofast Blue (trademarks). These chemicals indicate visibly attempts at forgery and/or tampering. The chemicals are added in amounts which are sufficient to indicate such attempts. Suitable quantities of said chemicals are equivalent to an amount in the fully converted paper of around 80 l/ton of paper.

It is true that it is previously known to add various security elements to paper pulp used for the manufacture of security paper for various types of security print. It is, however, not previously known to include security elements in a coating intended for security print. It is therefore surprising and unexpected that according to the present invention there is provided a base paper coated on both sides, which without objections is usable for the manufacture of lottery tickets and which from the security point of view fulfills the special require-

ments as regards products of this kind.

In an alternative embodiment of the invention, the base paper may be fusion coated, for example flow coated with hot melt plastic instead of being coated with a water-based coating mixture.

Further, the invention relates to a method of manufacturing lottery ticket paper in accordance with claims 6-8.

The lottery ticket paper according to the invention may be used for the manufacture of so called instant lottery tickets. The lottery ticket paper is printed on both sides with conventional printing inks or UV-fluorescent inks. One side of each ticket is printed with a figure combination which is unique for each lottery ticket. On the back of said ticket there is printed general information about the lottery in question, which information is the same on all tickets. The unique figure combination on the ticket is then covered with a coating comprising a conventional coloured latex solution. Such suitable latex solutions are well known and have been used, for example, on the conventional instant lottery tickets produced from foil-laminated paper material. After buying a ticket, the buyer rubs off the latex coating and is able to see directly whether he has won.

The use of the lottery ticket paper according to the invention is apparent from claims 9-10 and further an instant lottery ticket is stated in claim 11.

The invention will now be described in more detail by means of the following non-limiting examples.

#### Example 1:

Lottery ticket paper was prepared by applying a coating of around 20 g dry solid matter/m<sup>2</sup> and side of base paper to both sides of a base paper having a grammage of 225 g/m<sup>2</sup>, inked with carbon black, which had been added to the stock preparation during the manufacture of the paper. The coating mixture comprised a water dispersion of clay, titanium dioxide, latex and optionally viscosity regulating agents. The coating mixture was applied on both sides of the base paper by conventional methods, which are well known to a person skilled in the art. The coated paper was then dried and glazed in the conventional way in the drying section of the machine.

#### Example 2:

Lottery ticket paper was prepared as described in Example 1, except that the coating composition further comprised the security chemicals Securistain, Clorostain, Solvent Black and Nitrofast

Blue (trademarks) in an amount of 80l/ton of paper.

#### Example 3:

Lottery ticket paper was prepared as described in Example 1, except that the coating composition further comprised polyamide fibres in an amount of about 125 fibres/dm<sup>2</sup> of paper.

The products produced in accordance with Examples 1-3 have a uniform, even, white surface on both sides. The coatings may be printed with conventional printing inks and conventional printing equipment. The coated base papers produced in accordance with Examples 1-3 cannot be delaminated, since the coatings consist of a deposited composition originating from various powdered components.

#### Example 4:

A lottery ticket, so called instant lottery ticket, was prepared using a lottery ticket paper produced in accordance with Example 1. The ticket paper was printed on both sides with conventional inks intended for offset printing. Alternatively, UV-fluorescent inks may be used. One side of the lottery ticket paper was printed in an offset machine with figure combinations which were unique of each lottery ticket. The back of the paper was provided with suitable printed information which was the same on all lottery tickets and which was related to the lottery in question. The figure combination of the lottery ticket was then covered by coating with a coloured latex solution.

The lottery ticket was tested by the National Swedish Laboratory of Forensic Science, Linköping, Sweden, and was found to fulfill the requirements for see-through protection and tamperproofness.

The products produced are machine countable. They are nonexpensive to manufacture and have a relatively low weight, so that mailing expenses will be low. They are suitable to the environment and are easily destroyed in connection with refuse disposal. This means that, like ordinary printing paper, the lottery ticket paper may easily be recycled.

#### Claims

1 Lottery ticket paper comprising a coated base paper, characterized in that the base paper is a coloured opaque base paper which is coated on both sides with a composition comprising at least one pigment, a filler, a binder solution, and optionally viscosity regulating agents.

2 Lottery ticket paper according to claim 1, characterized in that the paper is coated with said composition to a substance equivalent to 10 g - 30 g dry solid matter/m<sup>2</sup> of coated side.

3 Lottery ticket paper according to claim 1, characterized in that the coating composition further comprises security elements, such as security chemicals, visible or non-visible fibres or a combination thereof.

4 Lottery ticket paper according to claim 1, characterized in that the composition is not fluorescent.

5 Lottery ticket paper according to any of the preceding claims, characterized in that the base paper is inked with a light-scattering pigment, preferably a black pigment, such as carbon black and that the pigment of the composition is a white pigment such as titanium dioxide.

6 A method of manufacturing lottery ticket paper comprising a coated base paper, characterized in that a coloured opaque base paper is coated on both sides with a composition comprising at least one pigment, a filler, a binder solution and optionally viscosity regulating agents, and the coated paper is then dried and aftertreated in the conventional way.

7 A method according to claim 6, characterized in that the coating composition further comprises security elements, such as security chemicals, visible or non-visible fibres or a combination thereof.

8 A method according to claim 6 or 7, characterized in that the base paper is inked with carbon black and the coating composition comprises titanium dioxide, clay, latex, water, and optionally additives in the form of security elements.

9 The use of a lottery ticket paper comprising a coated base paper for the manufacture of lottery tickets, characterized in that a coloured opaque base paper coated on both sides with a composition comprising at least one pigment, a filler, a binder solution and optionally viscosity regulating agents and security elements is provided with print on both sides, and one side of the lottery ticket is then covered at least partly by coating with a coloured latex solution.

10 The use of a lottery ticket paper for the manufacture of lottery tickets according to claim 9, characterized in that the coated paper is printed by means of known printing techniques.

11 An instant lottery ticket comprising a lottery ticket paper according to any of claims 1-5 and manufactured by the method according to claim 9 or 10.



European Patent  
Office

## EUROPEAN SEARCH REPORT

Application number

EP 90 85 0366.7

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 7)
X	GB-A-1 435 686 (CULTER GUARD BRIDGE HOLDINGS LIMITED) 12 May 1976	1-8	D 21 H 21/40
Y	*See claim 1, page 1, line 62, page 2 line 31 and 39, page 3 line 51*	9-11	
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Y	CH-C-598 964 (KARL SCHWEGLER AG) 12 May 1978 *See the whole document*	9-11	
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			TECHNICAL FIELDS SEARCHED (Int. Cl. 7)
			A 63 F B 42 B D 21 H
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
STOCKHOLM		08-02-1990	FALK I.
CATEGORY OF CITED DOCUMENTS			
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